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**CONTACT**

Dr. Julie Hansen
Department of Archaeology
675 Commonwealth Avenue / Room 347
Boston University
Boston, MA 02215
Telephone: (617) 353–3415

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# EDITOR'S VIEW

For the past year, the Society of Ethnobiology has been actively recruiting new members. I'd like to extend a special welcome to all those who are reading their first issue of the *Journal.* It seems a good time to say a few words about how the papers you will be reading came to be published.

The *Journal* publishes three types of refereed manuscripts: articles, short communications, and comments. An article describes original research in any area of ethnobiology. Length is variable: you must present enough background information, detail on methodology, and basic data for an educated reader to evaluate the validity of the conclusions you have drawn, while avoiding wordiness, repetition, and jargon. English, Spanish, and French abstracts are required for articles. A short communication is a brief presentation of the results of limited or preliminary research. No abstracts are required. A comment is a discussion of an article or short communication previously published in the *Journal.* Like articles and short communications, all comments are sent out for peer review. If the comment is accepted for publication, the author of the original article is invited to write a response and comment and response are published together.

After a manuscript is submitted (original and two copies), the editor sends it to an editorial board member, who chooses two reviewers. (Send me your name, address, phone/FAX/EMail numbers, and a description of your expertise in ethnobiology if you would like to review manuscripts.) After all reviews are back, a process that takes 8–12 weeks, the editor makes the final decision and informs the author that the manuscript (1) is accepted, (2) is accepted with minor revisions, (3) should be revised and resubmitted, or (4) is rejected. A great many manuscripts go through the "revise and resubmit" stage and are ultimately published: revise and resubmit is *not* rejection. The final stages of the process are copyediting, typesetting, and proofing, proofing, and more proofing.

The style guide for the *Journal* is published in issue 10(2); you may also write me for a copy. A few reminders for new and experienced submitters alike:

- French, Spanish, and English abstracts *are* required for article–length submissions. If translating your original abstract is a real problem, we'll help you out, but there is simply not the time or the money for the *Journal* staff to do everyone's translations.
- Double spaced means doubled spaced *everywhere* in the manuscript: abstracts, text, quotations, tables, bibliography, notes, and figure captions. Reviewers often write comments on the manuscript; the editor must copyedit for the

typesetter. These tasks are made very difficult if sections of the text are not doubled spaced.

- Word processors are wonderful, but resist the temptation to use fancy type—underline species and genus names and foreign words (no italic type, please); bold face may be used for foreign words for special emphasis (e.g., in an English text with both Spanish and Quechua common names, you may use bold face for Quechua), but is not required.
- You must provide page numbers for all quotations, long or short, and in an English text translations of any quotes not in English.
- Double check all scientific and foreign words for accuracy of spelling and accenting—the editors cannot do this for you.
- Double check the bibliography: most queries to authors during the copyediting process have to do with missing first names for authors and editors, missing publication locations, and the spelling out of abbreviations.

My thanks to all the board members and reviewers who assisted with manuscripts for issue 12(1). And special thanks to Chris Pulliam, who filled in for two issues as interim News and Comments editor. Gary Martin now takes over this job.

—DMP

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# EDIBLE WOOD FERN ROOTSTOCKS OF WESTERN NORTH AMERICA: SOLVING AN ETHNOBOTANICAL PUZZLE

NANCY J. TURNER
*Environmental Studies Program*
*University of Victoria*
*Victoria, B.C. V8W 2Y2*

LESLIE M. JOHNSON GOTTESFELD
*Department of Anthropology*
*University of Alberta*
*Edmonton, Alberta T6G 2H4*

HARRIET V. KUHNLEIN
*School of Dietetics and Human Nutrition*
*Macdonald College of McGill University*
*Ste. Anne de Bellevue, P.Q. H9X 1CO*

ADOLF CESKA
*Royal British Columbia Museum*
*Victoria, B.C. V8V 1X4*

ABSTRACT.—Many ethnographic reports refer to a large, "pineapple-like" fern rootstock which was an important native root vegetable in northwestern North America. It is suggested here that the primary, most commonly used edible type is *Dryopteris expansa,* with other, related species having been used in some localities and under some circumstances. The rootstocks were cooked in pits, often in winter when food was scarce. They are seldom eaten today and are known primarily by native elders. Several botanical identifications for this food have been suggested in *Dryopteris, Athyrium,* and other fern genera. Species verification has been complicated by lack of botanical expertise among early reporters, difficulty in recalling the fern characters by elders, and taxonomic complexities of the ferns. Rootstocks of *D. expansa* were harvested by the Nuxalk at Bella Coola, cooked, and prepared for nutrient analyses. Proximate composition and energy are similar to that of the common potato, but Ca, Mg, Zn, Cu, and Mn were present in levels several-fold higher than that of potato.

RESUMEN.—Varios informes etnográficos se refieren a un rizoma grande, "semejante a una piña," de un helecho, que era una importante raíz alimenticia nativa en el noroeste de Norteamérica. Se sugiere aquí que el tipo comestible primario, más comunmente usado, es *Dryopteris expansa,* habiéndose empleado otras especies emparentadas en algunas localidades y en ciertas circunstancias. Los rizomas se cocían en cavidades en el suelo, con frecuencia en el invierno cuando escaseaba la comida. En la actualidad se comen muy poco, y son principalmente los ancianos indígenas quienes los conocen. Para este alimento se han sugerido varias identificaciones botánicas en *Dryopteris, Athyrium* y otros géneros de helechos. La verificación de la especie se ha complicado por la falta de pericia botánica entre los primeros observadores, la dificultad en recordar las características de los

helechos por parte de los ancianos, y la complejidad taxonómica de los helechos. Colaboradores Nuxalk cosecharon rizomas de *D. expansa* en Bella Coola, que se cocieron y prepararon para análisis nutricional. Los análisis bromatológicos básicos arrojaron resultados similares a los de la papa común, incluyendo su valor energético, pero se encontraron niveles de calcio, magnesio, cinc, cobre, y manganeso varias veces más altos que los de la papa.

RESUME.—De nombreux rapports ethnographiques font référence à de grosses racines de fougère, semblables à un ananas, qui étaient un important légume local en Amerique du Nord. L'hypothèse est émise que le type comestible primaire et le plus utilisé est la *Dryopteris expansa* alors que d'autres espèces proches étaient utilisées dans certaines localités et dans certaines circonstances. Les racines étaient cuites dans des trous, souvent en hiver, lorsque la nourriture se faisait rare. Elles sont rarement consommées aujourd'hui et sont surtout connues des personnes âgées. Différentes identifications botaniques pour cet aliment ont été suggerées dans *Dryopteris, Athyrium* et d'autres genres de fougères. La vérification botanique a été rendue difficile par le manque d'expertise botanique des premières sources, par la mauvaise mémoire des anciens à propos des caractèristiques des fougères, et par leur complexité taxonomique. Les racines de *D. expansa* furent recoltées par les Nuxalk a Bella Coola, cuites et preparées pour être analyseés. La composition ''proximate'' et l'energie sont similaires à celles de la pomme de terre commune mais le Ca, Mg, Zn, Cu, et Mn y sont presénts en plus grande quantité.

## INTRODUCTION

Ferns are an important component of northwestern North American flora. The moist, mild coastal climate is ideal for the growth of many Pteridophyte species, and the diversity of habitats and microclimates is reflected in the diversity of species of ferns. Many reports have been published concerning the edibility of certain ferns by native peoples of the region (cf. Gunther 1973; Turner 1975). The use of the rhizomes of western bracken fern *(Pteridium aquilinum* (L.) Kuhn) as food by Northwest Coast peoples has been well documented (cf. Norton 1979). The rhizomes of licorice fern *(Polypodium glycyrrhiza* D.C. Eat.) are also well known, even today, as a mouth sweetener and appetizer, although they were seldom eaten in any quantity (cf. Turner and Bell 1973; Turner 1973, 1975).

Perhaps the most intriguing and puzzling ''fern food'' is the rootstock recalled by many contemporary native elders and widely cited in the literature as a large, ''pineapple-like,'' or ''banana-like'' clump of ''fingers'' which was cooked and eaten traditionally, both as a regular part of the diet and as emergency rations, along the coast from Oregon to Alaska and inland in British Columbia. There is probably more confusion about the identity of this edible fern rootstock, hereinafter called wood fern in a general context, than about any other traditional food plant in northwestern North America.

One of the earliest literature references to edible wood fern is by Gorman (1896), who identified it as *Dryopteris spinulosa* [''*Aspidium spinulosum* var. *dilatatum* (Wood-fern)''] and provided the following account of its use by the Coast Tsimshian of southeastern Alaska (Gorman 1896:78–79):

> [Wood-fern] . . . is abundant in rich open woods near sea level, and the rootstock or caudex is highly relished by the natives, who cook and eat it in large quantities, it being the first vegetable food which they obtain in early spring. [It] . . . is called *"Ahh,"* by the Tsimsians, who inform me that it is larger, sweeter, and of better flavor when grown under or in the vicinity of salmon berry bushes . . .

Ethnographers without botanical knowledge described the fern in the most general of terms. For example, J.P. Harrington, in his unpublished ethnographic notes, referred to it under a Suquamish place name for a creek at Miller Bay ("Miller's Inlet") on the Port Madison Indian Reservation in Washington:

> ***du ts'kweb*** Means:- ***ts'akwe'*** = root used to eat long ago. Grows in marshy place. Have heavy roots like a ball. Grass [Fronds] like feathers. 1 ft high. Black on surface & white inside. Grow up like fingers in bunches.[1]

Barbara Lane (personal communication to NJT, 1984) described the same Suquamish fern in more detail, based on descriptions by Native people she consulted:

> It ***[ts'Ekwi]*** is styled variously the "fossil fern," "evergreen fern," and "Indian banana." It is a tall plant, and grows on logs in damp places. A cluster of edible pods is found at the bottom of the stalks, looking like one's hands placed palm to palm. The Indians gathered these pods and baked them as they did clams, burying them in a pit with hot stones. The existence of these plants on the west side of the bay gave the place its name . . . Miller Bay used to be called Squaib Bay, clearly a rendering of the native term for the fern.

Edible wood fern rootstocks, all having more-or-less similar descriptions and methods of gathering and preparation, have been described and identified as *Dryopteris austriaca* (Turner 1975; Heller 1976; Oswalt 1957), *D. filix-mas* (Turner 1973, 1975), *D. dilatata* (Kari 1987—*"D. dilata," [sic]*), *D.expansa* (cf. Lepofsky et al. 1985), *D. spinulosa* (Gorman 1896—*"Aspidium spinulosum* var. *dilatatum;"* Harlan Smith, unpublished notes, 1920-1921[2]—*"Aspidium spinulosum"*), *Thelypteris limbosperma* (Norton 1981), *Cystopteris bulbifera* ('Ksan, People of 1980), *Athyrium filix-femina* (Kari 1987; Harlan Smith, unpublished notes, 1920-21—*"Asplenium cyclosorum"*), and *Polystichum munitum* (Turner 1975; Turner and Bell 1973; Nancy Turner unpublished notes on Haida, 1971).[3] *D. spinulosa, D. dilatata, D. austriaca,* and *D. expansa* are considered to be in the same taxonomic complex, as explained later. In most, if not all cases, the identifications were made on the basis of selection and information provided by Native elders.

Potentially all of these species were used but, logically, some citations result from confused or mistaken identifications. In this paper, we present evidence to indicate that the "real" wood fern rootstock—the one normally used as food—

is that of *Dryopteris expansa,* but that on occasion other, similar types of fern rootstocks were also consumed.

The confusion surrounding the identification of the edible wood fern is exemplified in the unpublished notes of Harlan I. Smith on plant use by the Nuxalk (Bella Coola) and Carrier Indians of central British Columbia. Smith referred in several places to an edible fern called ***sq'wálm ("squalum"),*** which had a " . . . part like a pineapple at the base [that was] used for food." In his Carrier ethnobotany notes, he identified it as *Athyrium filix-femina*[4] and noted, "Leaves coarser and less bifurcated than the shield fern." In his Bella Coola ethnobotany notes, he identified ***squalum*** as *Dryopteris expansa*[5] and also attributes the name ***"Xala"*** to this species. Then, he notes: "Trouble. Same species given two different Bellacoola names, one useful for food only, the other used for medicine." His native Bella Coola consultant evidently applied the two native terms to different specimens of the same species. Adding further confusion, a third term, ***"kamatz,"*** was applied by Smith's Native consultants to the tops (fronds) of *Dryopteris expansa* (see previous footnote) and *Athyrium filix-femina*[6] with a note under the latter: "Trouble. Joshua [Moody] calls this the same as Shield Fern 7 (54M) with which it was collected; yet that is the same species as 7 (77M) which he calls ***squalum*** [both of these are actually *Dryopteris expansa*]."

Elsewhere in his unpublished notes, Smith mentioned two other fern species which were sometimes mistaken for the real ***squalum.*** Under *Polystichum munitum,* sword fern, he noted: " . . . This plant was not used for food . . . but was [sometimes] mistaken . . . for another fern called ***squalum.*** The two forms were distinguished by the leaves as the banana–like parts appear the same and both are easy to pull up. The leaves of the sword fern . . . do not die in winter . . . " Under an unidentified fern ***"See el i tana,"***[7] he noted that this one was " . . . a little different from ***squalum.*** Sometimes people . . . mistake it for ***squalum.*** It is not good food. ***Squalum*** is [a good food] . . . Roots same and top same as ***squalum.*** I think ***squalum*** has no spores and ***See el i tana*** has." Smith's Carrier notes are equally confusing.[8]

As will be seen, research within the last two decades at Bella Coola has resulted in clarification of some of the confusion surrounding ***sq'wálm,*** but the problems that faced Harlan Smith and the Native people he worked with seem to have been repeated in virtually every area where wood fern was eaten. Furthermore, plant taxonomists have also been confounded in the scientific classification of wood ferns, and the many synonyms and nomenclatural discrepancies for various *Dryopteris* species have made the problem of identification especially difficult.[9]

The aim of this paper is to resolve, as much as possible, the questions arising from the bewildering and sometimes conflicting array of botanical and ethnobotanical information on the edible wood fern in northwestern North America, and to document the traditional importance of this food in Native cultures. We will summarize the botanical and taxonomic features of the wood fern complex in northwestern North America, and relate the botanical characteristics to the utility of the plant. Then we will review the Native terminology, descriptions, and use of the edible wood fern, using information derived both from literature sources and from interviews with contemporary Native

consultants in various speech communities of the region. Nutrient data from specimens collected and prepared at Bella Coola are provided, as well as use frequency and taste appreciation data. Information on non-food uses and the importance of wood fern in mythology and traditional beliefs is also given.

## BOTANICAL AND TAXONOMIC ASPECTS OF THE WOOD FERN PUZZLE

*Narrowing down the species.*—The fern species reported in this study to have edible, "pineapple-like" rootstocks fall into five genera. These are annotated and evaluated as follows (see also descriptions in Scoggan 1978 and Taylor and MacBryde 1977):

*Cystopteris* — *C. bulbifera* ('Ksan, People of 1980); does not occur in British Columbia (Scoggan 1978); concluded to be erroneous identification;

*Thelypteris* — *T. limbosperma* (Norton 1981); voucher specimen (*613* WTU) examined by Adolf Ceska in 1989 and found to be *Athyrium filix-femina;*

*Athyrium* — only *A. filix-femina* (L.) Roth (lady fern) has rootstocks large enough and distribution wide enough to "qualify;" has been identified on occasion as the edible type (see previous entry), but usually rejected;

*Polystichum* — only *P. munitum* (Kaulf.) Presl (sword fern) has large enough rootstocks to be the edible type, and has occasionally been suggested as such in literature citations,[10] *P. braunii* (Spenner) Fée (Braun's holly fern) has rootstocks large enough, but has never been cited in ethnobotanical or ethnographic literature as having been eaten;[11]

*Dryopteris* — most frequently cited as having edible rootstocks; taxonomic treatments for the genus widely variable (cf. Hultén 1968; Calder and Taylor 1968; Scoggan 1978); some species ruled out because of size or range,[12] leaving *D. filix-mas* (L.) Schott (male fern) and two species of the "*Dryopteris expansa* complex:" *D. carthusiana* (Villars) H.P. Fuchs[13] and *D. expansa* (K.B. Presl) Fraser-Jenkins and Jermy; (see Walker 1955, 1961; Britton 1962, 1968, 1972; and Widen and Britton 1971 for detailed discussions of the taxonomy of this complex).

Of the *Dryopteris* species mentioned, *D. filix-mas* was identified in one case (Turner 1973) but the *Dryopteris expansa* complex has been more consistently recognized. The two species from this complex are similar, but *D. carthusiana* (syn. *D. spinulosa* [O.F. Müller] Watt) has fronds with more or less parallel sides at their lower part and has a chromosome count of 2n = 164, whereas *D. expansa* (syn. *D. assimilis* S. Walker, *D. dilatata* [Hoffm.] A. Gray var. *alpina* Moore) has fronds more or less triangular in outline, with a chromosome count of 2n = 82. The latter is common in northwestern North America; the former is less frequent, but where it occurs, it may grow side by side with *D. expansa* (e.g., in Exchamsiks River Provincial Park in northern British Columbia). Of all the species mentioned, the one most frequently and consistently cited as *THE* edible wood fern of northwestern Indigenous Peoples, when synonymy is considered, is *Dryopteris expansa.*

*Native perceptions.*—Given the complex situation of so many, widely variable fern species and genera sharing at least some characteristics, it is not surprising that

Native people have often provided varying and confusing identifications and descriptions of the edible wood fern and others they consider to be related.

McIlwraith (1948, in his Appendix C), in discussing folk classification of the Nuxalk (Bella Coola) adds another perspective to the problem: "In regard to plants, a difficulty lies in the fact that Bella Coola nomenclature is not always strictly botanical. Two or more distinct ferns, for example, may be grouped together on account of their similar use as food and one name applied to them indiscriminantly ..." A Haida Native elder, the late George Young, stated the same concept in discussing several ferns given the same Haida names[14]: "One word can mean so many names. It's all in the way the sentence or the subject is brought up. You can have one word for two completely different kinds of plants . . ."

The close perceptual relationship among various ferns is shown in the Nuxalk area by the term ***qaxmats,*** mentioned previously in the introductory discussion of Harlan Smith's unpublished notes, which is sometimes applied to the fronds of *Athyrium, Dryopteris, Polystichum,* and *Pteridium*[15] although the rhizomes are usually given different names. The identification of the true edible wood fern, ***sq'wálm,*** must be made from the appearance of the rootstock, not the aerial parts. Nuxalk elder Felicity Walkus once applied the name to specimens of both *Dryopteris expansa* and *Athyrium filix-femina* growing side by side[16], but when she examined the rootstocks after they were dug up, she stated that only the *Dryopteris* was the true ***sq'wálm.*** This identification was confirmed by Margaret Siwallace and two other Nuxalk elders. The *Athyrium* rootstock, they said, was the one called ***xala***, which was like that of the edible fern, but smaller, blacker, and covered with dark hairs. Grizzly bears are said to like to eat ***xala,*** but it makes them cranky (Nancy J. Turner, unpublished notes on Nuxalk, 1981). Margaret Siwallace later stated that there were four types of fern that were almost alike. The one with fleshy, round "fingers" (leaf bases) was ***sq'wálm,*** the "flat one," ***xala,*** was poisonous, and two other kinds are similar to ***sq'wálm,*** and edible, but not quite as good (Nancy J. Turner, unpublished notes on Nuxalk, 1983).

Lillooet consultants definitely excluded *Athyrium* as the edible wood fern, although one elder called it "a kind of" ***c'əkwa?*** *(Dryopteris)*. Its big, black "roots" are said to be so tough that even a plough cannot go through them (Randy Bouchard, personal communication to NJT, 1974). One specimen collected with Lillooet elders and said to be the edible kind was identified as *D. carthusiana*[17]

In the Skeena drainage of northern British Columbia, a number of different identifications have been made of ***ax***, the plant with edible rootstocks. *Athyrium filix-femina* and *Dryopteris filix-mas* plants in leaf were pointed out as ***ax*** by David Green, a knowledgeable Gitksan elder (Leslie M.J. Gottesfeld, unpublished notes, 1988).[18] Later in the season, however, he identified *Dryopteris expansa* as ***ax***, and excluded *Athyrium*. Another Gitksan consultant, Jeff Harris Sr. of Kispiox, who as a child had frequently collected edible fern rootstocks with his grandmother, pointed out that the edible type was recognized from the rootstock, rather than from the tops. The fern was sought and dug up after the fronds had withered. Ferns with a small rootstock, or ones with small or flattened leaf bases, were called ***dumtx***, a term signifying "non-edible fern." During a field trip specifi-

cally undertaken to identify and collect ***aǎx̌***, plants of *Athyrium filix-femina* and *Dryopteris filix-mas,* and a small specimen of *D. expansa* were all classified as ***dumtx*** by Jeff Harris. The last was described as being almost like ***aǎx̌***, but too small. Its broken "fingers" or leaf bases had the distinctive pea green colour of ***aǎx̌***. It was collected in a small organic soil pocket in the hemlock forest, not in the snowbed or avalanche chute habitat preferred by the Gitksan in their interior geographic location. Larger, more robust specimens of *D. expansa*, found in the snowbed locality, were dug up and pronounced to be ***aǎx̌***, because of the relatively large size of the rootstock, the diameter of the "fingers," and their green color (Leslie M.J. Gottesfeld, unpublished notes, 1988.[19]

Additional insight into native perception and classification of ferns comes from Gordon Robinson, a Haisla elder from Kitamaat Village. When shown a specimen of *Dryopteris expansa* and asked if it was the edible fern root, he commented, "You can tell if it is the right fern if the 'fingers' are round [in cross section], pale green inside, and brittle. It grows in the forest on top of fallen logs and on stumps. It grows at the base of slide areas . . . You can kick it out of the ground or pull it out easily. Other ferns, you need a pick [to dig up] . . . "(Leslie M.J. Gottesfeld, unpublished notes, 1988).[20] It is significant that when one collects a fresh rootstock of *Athyrium filix-femina,* the "fingers" are tan inside, woody textured, and triangular in cross–section. In addition, the large, fibrous root system is very hard to pry out of the soil (Leslie M.J. Gottesfeld, unpublished notes, 1988).

*Habitat considerations.*—Locations where the edible fern rootstock grows in adequate abundance and quality for harvesting in British Columbia are generally scattered and infrequent. It is a slow–growing perennial fern and hence may be several years old before it is big enough to harvest. Following are some notations on the best habitats or localities observed for edible wood fern growth and/or harvesting (Native group and literature citation given in parentheses):

—near salmonberry bushes *(Rubus spectabilis)* (Tsimshian; Gorman 1896);

—hillsides and under cottonwood trees *(Populus balsamifera)* and alders *(Alnus rubra);* wooded locations up to 800 m (Tanaina; Kari 1987; Ray ca. 1980);

—"half way up the mountains" in "meadows" or "ravines" (avalanche tracks), open snowbed communities; best locations had ownership harvesting claims (Gitksan, Wet'suwet'en; Jeff Harris, Sr., Beverley Anderson, personal communication to LMJG, 1988);

—plentiful around Kuldo (deserted Gitksan village about 90 km north of Hazelton) and around other, modern Gitksan villages; Kuldo people were teased in song about their consumption of the fern rootstocks (Gitksan; 'Ksan, People of 1980);

—at the base of big cliffs in avalanche paths; areas frequented by mountain goats, who survive on wood fern rootstocks during the winter (Haisla; Gordon Robinson, n.d.; see note 20);

—higher elevations at the base of snow banks and rockslides (Nuxalk; Turner 1973);

—swampy areas (Mainland Comox; Randy Bouchard, personal communication to NJT from 1973 research);

—Fountain Valley, about 1.6 km past Rusty Creek, called ***sts'ets'kwa7*** after wood fern (Lillooet; Randy Bouchard, personal communication to NJT from 1974 research);

Because it is so infrequent and because harvesting eliminates an entire plant, care must be taken by those harvesting this food to leave sufficient plants behind in each locality for any future harvests, or entire populations of this historically important food plant could be eliminated.

*Native food use of wood fern rootstocks.*—A summary of ethnographic reports and native nomenclature for edible wood fern rootstocks is provided in Table 1. As shown in this table, edible wood fern rootstocks were used by virtually all Northwest Coast Native peoples of British Columbia, as well as by the Lower Thompson, Lillooet, Nishga, Gitksan, and Wet'suwet'en, by the southeast Alaskan and western Washington Indian groups, and even by some Eskimo peoples of Alaska. In all, folk names for this food were used in over 25 different Native languages in the region. Fig. 1 shows the extent of former wood fern use in northwestern North America.

TABLE 1.—Summary of ethnographic reports and native nomenclature for edible wood fern rootstocks.

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| Nuxalk (Bella Coola, Salish) | ***sq'wâlm*** (rhiz.); ***sq'wâlm-iix̌w***, ***sq'walq'wâlm-iix̌w*** (plant) | *Dryopteris expansa* (most people), *D. filix-mas* (some people), and *Athyrium filix-femina* (some people, but probably mistaken) (Nancy J. Turner, unpublished notes, 1981, in possession of NJT; Turner 1973; Harlan I. Smith, unpublished notes, ca. 1920–22, National Museum of Civilization, Ottawa) |
| Lillooet (Salish, Interior) | ***c'ə́kwa?*** | *Dryopteris* spp. (Nancy J. Turner, Randy Bouchard, Dorothy Kennedy, Jan Van Eijk, unpublished notes, 1974–86, in possession of NJT); *Athyrium filix-femina* said by some to be "a kind of ***c'ə́kwa?***," but not the kind with edible rootstocks (cf. coll. V 88,796, 88,798–9, N. Turner: *D. carthusiana*). |

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| Thompson (Salish, Interior) | not recalled | *Dryopteris* spp. (Turner et al. 1990); eating of pit-cooked fern rootstocks recalled, but not identity; ***c'úkʷi7***, the term cognate with wood fern rootstocks in other languages, applied to fresh rhizomes of *Pteridium aquilinum* by Annie York |
| Comox (Salish, Coast) | ***th'ékwa*** | *Athyrium filix-femina* (Randy Bouchard, unpublished notes on Mainland Comox, 1973–76); identified from specimens by Bill and Rose Mitchell (Randy Bouchard Coll. Nos. 44, 4, V) |
| Sechelt (Salish, Coast) | ***stsawch*** | unidentified fern (*Athyrium* or *Dryopteris*) whose rootstocks with finger-like appendages were pit-cooked and eaten (Nancy Turner and Jan Timmers, unpublished notes on Sechelt ethnobotany, 1972, in possession of NJT) |
| Sechelt (Salish, Coast) | ***x̌wúlhqw'at*** | unidentified "type of fern, something like a turnip," with a texture "something like garlic," which grows in the mountains, especially at a place called ***x̌énichen*** (J. Joe, personal communication to Randy Bouchard, 1978) |
| Squamish (Salish, Coast) | ***ts'ékwa7*** | "*Dryopteris austriaca*" and, by some, *Polystichum munitum* also (rootstocks) (Bouchard and Turner 1976) |
| Halkomelem (Upriver) (Salish, Coast) | ***th'ékwa*** | "mountain fern with wide top" (Galloway 1982) |
| Clallam (Salish, Coast) | ***tsa'qwa*** | "*Dryopteris dilatata*" (Gunther 1973) |

TABLE 1.—Summary of ethnographic reports and native nomenclature for edible wood fern rootstocks. (continued)

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| Straits (Northern) (Salish, Coast) | ***tsō'kwī*** | (Kinkade 1989)[2] |
| Straits (Lummi) (Salish, Coast) | ***tsuk'kwa*** | "small brake fern" (Kinkade 1989; original, George Gibbs 1863) |
| Lushootseed (Suquamish) (Salish, Coast) | ***ts'E'kwi*** | unidentified fern (Barbara Lane, personal communication to NJT, 1985; from unpublished notes of T.T. Waterman ca. 1920 and J.P. Harrington ca. 1910) |
| Lushootseed (Green River) | ***tsō'kwī*** | "*Dryopteris dilatata*" (Gunther 1973) |
| Lower Chehalis (Salish, Tsamosan) | ***c'qʷí?*** | "fern sp." (Kinkade 1989, original from J.P. Harrington field notes, 1948) |
| Upper Chehalis (Salish, Tsamosan) | ***c'aqʷé?*** | "tiger-lily root" (Kinkade 1989) |
| Sahaptin (Taidnapam, Upper Cowlitz, or Yakima dialect) (Sahaptin) | ***ts'kwai*** | "*Dryopteris dilatata*" (Gunther 1973, who calls this language "Cowlitz;" M. Dale Kinkade, personal communication to NJT, 1989) |
| Quileute (Chimakuan) | ***ts'ikʷí; c'iqʷó pat*** | "fern roots" (J.V. Powell and F. Woodruff in Gunther 1973; Powell and Woodruff, Quileute Dictionary, |

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| | | from M. Dale Kinkade, personal communication to NJT, 1989) |
| Kwakwala (Wakashan) | ***tsákus*** (rhizome); ***tságanu*** (leaves); ***tsákusm̓es*** (plant) | *"Dryopteris spinulosa dilatata," D. austriaca* and *Polystichum munitum* both types of which were eaten (Boas 1921, 1934; Curtis 1915, "wood-fern roots;" C. F. Newcombe[3]; Turner and Bell 1973) |
| Haisla (Wakashan) | ***t'ibàm*** (rhizome); ***t'ip̓às*** (plant) | Lincoln and Rath 1986 — "edible fern root;" "... plant, leaves" (cf. ***t'ìpa*** "to step, tread on something"); Curtis 1907, "wood fern" |
| Heiltsuk (Wakashan) | ***t'ìbàm*** (rhizome); | Brian Compton, personal communication to NJT, 1988[4] (cf. ***t'ìpa*** "to step, tread onto something; to find fern roots or cockles by feeling with the feet"); Boas 1928 ***"t!e'bEm"***—root of *Dryopteris austriaca* |
| Oowekyala (Wakashan) | ***teí-pŭm*** | "fern-roots (wood fern)" (Curtis 1915) |
| Nuu-chah-nuulh (Hesquiat) (Wakashan) | ***t'ipa·*** | unidentified fern closely resembling *Dryopteris austriaca* and *Pteridium aquilinum* but not the same, whose rootstocks were eaten long ago (Turner and Efrat 1982) |
| Nuu-chah-nuulh (Clayoquot) | ***t̓í-p̓a*** | "fern-roots (wood fern)" (Curtis 1916) |
| Ditidaht (Wakashan) | ***t'it'eɬsapt*** | *Polystichum munitum* (Turner et al. 1983); (cf. ***t'it'eɬs*** "crouching" for |

TABLE 1.—Summary of ethnographic reports and native nomenclature for edible wood fern rootstocks. (continued)

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| | | fiddlehead shoots); rootstocks pit-cooked and eaten. |
| Quileute (Chimakuan) | ***ts'ikwi*** | *Polystichum munitum* (roots) (Gunther 1973); Quileute said to bake rhizome in a pit and eat with salmon eggs. |
| | ***tseqwē'*** | *Athyrium filix-femina* (root) (Gunther 1973); Quileute said to eat roasted, peeled rhizomes |
| Coast Tsimshian (Tsimshian) | ***"ahh"; aa*** (?) | *"Aspidium spinulosum* var. *dilatatum"* (Gorman 1896); "an edible root; a root medicine" (Dunn 1978) |
| Nishga (Tsimshian) | ***aẍ*** | *"? Athyrium filix-femina"* (McNeary 1974) |
| Gitksan (Tsimshian) | ***aẍ*** | *"Cystopteris bulbifera"* ('Ksan, People of 1980); *"Dryopteris filix-mas"* (Gitanyow Summer Student Research Program 1984); *Dryopteris expansa* (Leslie M.J. Gottesfeld, unpublished notes, 1987, 1988) |
| Tlingit (Tlingit) | ***k'wâlx̌, k!wAɬx*** | *Dryopteris expansa* (Leslie M.J. Gottesfeld, unpublished notes 1987, 1988); *"Dryopteris spinulosa"* (Swanton 1909) |
| Chilcotin (Athapaskan) | ***ʔax***$^{5}$ | Nancy J. Turner (unpublished notes, 1988); Teit (1909:780) noted that "fern-root" was eaten by the Chilcotin; Morice (1893) stated that *"• ah"* was not found in Chilcotin country |

| Language (Family) | Native Name[1] | Identification; Notes; Reference |
|---|---|---|
| Carrier (Athapaskan) | *'' ·ah'',* or *ah chŭn* | Morice (1893); second term from Smith (unpublished notes on Carrier, ca. 1920–22)—identified as ''Shield Fern'' (see note in text) |
| Wet'suwet'en (Athapaskan) | *di yii'n* | *Dryopteris expansa* (Leslie M.J. Gottsfeld, unpublished notes 1987, 1988) |
| Tanaina (Athapaskan) | *uh* | *Dryopteris dilatata* (Kari 1987) |
| Haida (Skidegate) (Haida) | *ts'ágwl; djagwal; skyaw* (''tail'') | applied variously to large, edible rootstocks of *Dryopteris austriaca, Polystichum munitum, Athyrium filix-femina* (Turner, unpublished notes on Haida, ca. 1971; see Note 3 in text) |
| Haida (Masset) (Haida) | *ts'ágwl; tanskyaw* (''black-bear's tail''); *snán-djang* | applied variously to large, edible rootstocks of *Dryopteris austriaca, Polystichum munitum, Athyrium filix-femina* (Turner, unpublished notes on Haida, ca. 1971; see Note 3 in text) |
| Haida (Kaigani) Haida) | *sk'yáaw* (rhizome) | *''Thelypteris limbosperma''* (Norton 1981); specimen later reidentified by Adolf Ceska as *Athyrium filix-femina* |
| Western Eskimo (Inuit) | *wingísuk* | *Dryopteris dilatata* (Oswalt 1957) |

[1]Orthography used in original source is given, except $\underline{k} = q$; $\underline{x} = \dot{x} = \breve{x}$. For simplicity, not all reported terms for *Athyrium filix-femina* or *Polystichum munitum* are included in this table, only those cognate with terms applied to *Dryopteris* spp. or directly associated with reports of edible rootstocks.

[2]M. Dale Kinkade (personal communication to NJT, 1989) notes that the name for spiny wood fern is reconstructable in Proto–Salish, and hence provides evidence for coastal origins for Salish (cf. Kinkade 1989).

[3]C.F. Newcombe gives several variations of the term ***tsakos*** in various parts of his unpublished notes and manuscripts (Newcombe Coll. Vol. 43, File 36, ca. 1922, Provincial Archives of British Columbia); at least two were confirmed by Kwakwala speaker and linguist George Hunt; all refer to *''Dryopteris dilatata''* or its synonyms.

[4]Brian Compton compiled a comprehensive list of fern names for Kwakwala and related languages, entitled ''North Wakashan Pteriodophyte Nomenclature & Terminology'' (1988), which contains a much more complete list of fern species and related terminology in Kwakwala, Haisla, Heiltsuk, and Oowekyala (Rivers Inlet) (ms. in possession of Brian Compton, Department of Botany, University of British Columbia, Vancouver, BC).

[5]This name was given by Robert Tyhurst (1975–76, unpublished notes on Chilcotin ethnobotany, in possession of RT, Victoria, British Columbia) as bracken fern *(Pteridium aquilinum),* but recent evidence suggests a *Dryopteris* species, from the descriptions of the clustered rootstocks.

Many descriptions exist of the edible wood fern and its use. The rootstocks with their attached leaf bases have been variously described as ''like 2 hands clasped together'' (Norton 1981; B. Lane, personal communication, 1984), ''like a woody sweet potato'' ('Ksan, People of 1980), ''resembling a bunch of bananas'' (cf. Kari 1987; Ray ca. 1980; Turner 1973), ''like a pineapple'' (Harlan I. Smith, unpublished notes ca. 1920; Turner 1973), a ''big root with little fingers'' (Willie Matthews, Haida elder, tape transcript by Nancy J. Turner, ca. 1970), or having many brown ''fingers'' growing around it (Turner 1973). The ''good'' fingers are succulent. Figures 2–4 show the characteristics of the edible wood fern (i.e.,*Dryopteris expansa)*.

Gitksan elder Jeff Harris Sr. described the edible fern rootstock as being about as big as his hand (fist), and noted,'' . . when you take them out the root tapers down to the bottom, when you dig it out, and crooked. You have to take the little piece of the bottom part out because it's small . . . that [leaf base] would be about the size of your little finger . . . the banana-like root. You take them off and peel it with your finger . . .'' (Leslie M.J. Gottesfeld, unpublished notes, 1987). The fern rootstock is described as being greenish inside when raw, but turning to yellowish or orange when cooked (Jeff Harris, David Green, Lizette Naziel, personal communications to LMJG, 1987).

*Harvesting.*—The rootstocks were usually dug in spring or fall (cf. 'Ksan, People of 1980). The Nuxalk name for the fourth moon after the summer solstice is called ***siqaalx̌manm*** (lit.''time to get ***sq'wálm***''). At this time, many of the ''fingers'' on the rootstock are plump and round, whereas earlier many are flat and no good for eating. Potatoes are dug at this time too, according to Margaret Siwallace (Turner 1973). However, the wood fern rootstocks could be dug out even in December if it was a mild winter, and could be dug from under the snow if necessary. Wet'suwet'en consultants stated that wood fern rootstocks should be gathered in fall after the leaves wither or in the winter (Josephine Michell 1987, Madeline Alfred 1988, Lizette Naziel 1987, Sara Tait 1988, all personal communications to LMJG). It was stated that the rootstocks are not damaged by freezing and could be dug from under the snow. A special wooden snow shovel was

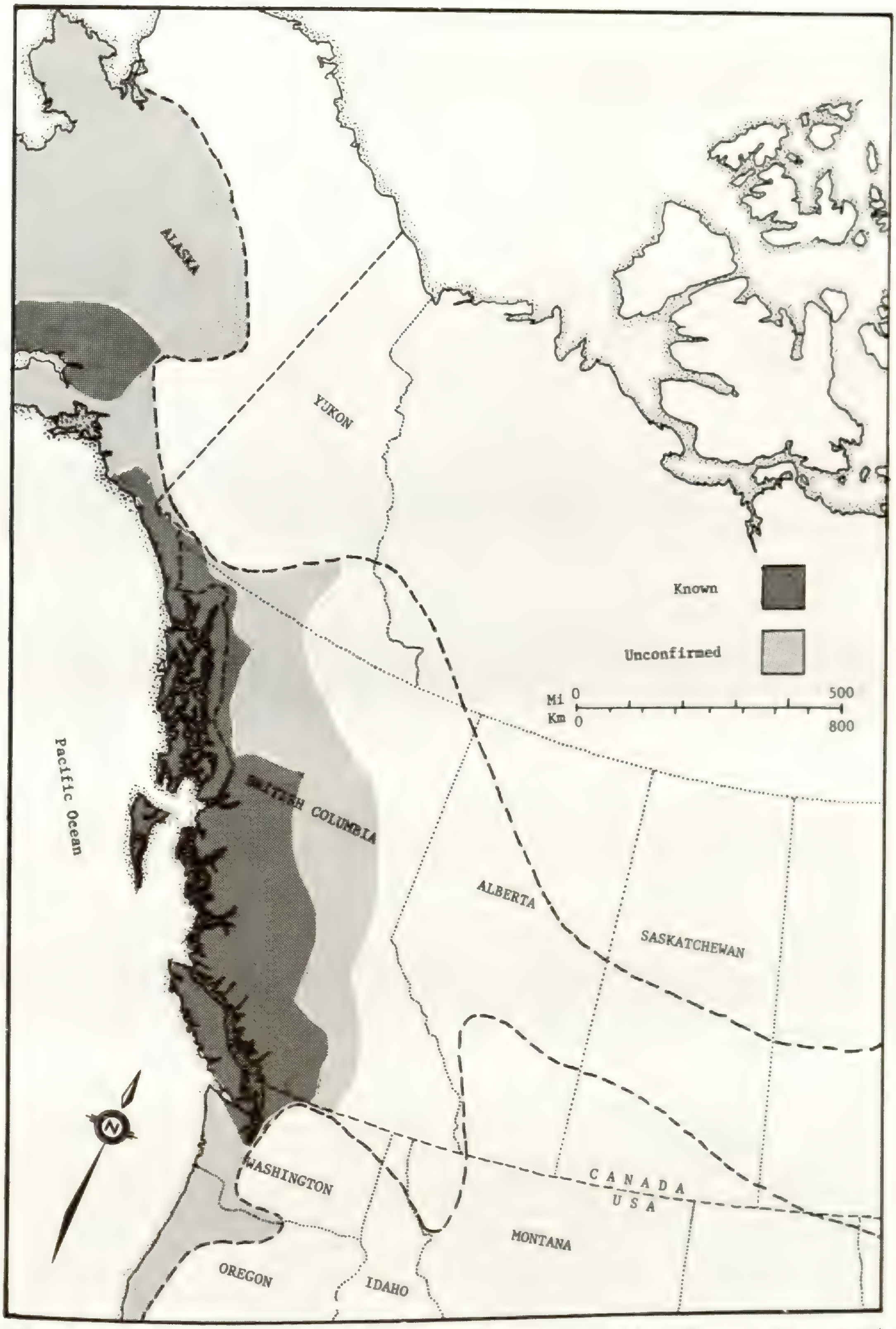


FIG. 1.—Extent of former use of edible wood fern (mainly *Dryopteris expansa)* in northwestern North America. (The heavy dotted line shows the approximate distribution of *Dryopteris expansa* over the same area.)

FIG. 2.—Rootstock of *Dryopteris expansa,* showing ''finger'' formation of leaf bases from previous years' fronds.

used to uncover the plants (Madeline Alfred, personal communication to LMJG, 1988). Gitksan consultants stated that fern rootstocks were gathered in fall, winter, or spring before the fronds begin to uncurl. Plants were located by the ''whitish stick sticking up'' or the ''curly leaf'' (fiddlehead). Digging the rootstocks out of frozen ground was laborious, but their availability in the winter season made them a valuable food. Some Tanaina people say they can be dug at any time of the year, but others say that they are dry and unpalatable during the summer months. Some say the rootstocks are juiciest and most palatable in the fall, others in the spring (Kari 1987).

Since the rootstocks were usually sought after the tops had died down, finding them was sometimes difficult. The Haisla and Heiltsuk people evidently had a unique way of locating them with their feet, as alluded to in their term, ***t'íp̓a,*** meaning ''to step, tread onto something; to find fern roots or cockles by feeling with the feet'' (Heiltsuk), and in ***t'íp̓s,*** meaning ''one's feet touching the ground (as when feeling for fern roots)'' (Heiltsuk) (Brian Compton, personal communication to NJT, 1988; terms given to him by Kitlope elder, Gordon Robertson; see also Lincoln and Rath 1986 for Haisla). It is not clear whether the actual names for the edible wood fern are derived from these terms, or vice versa.[21] According to Gordon Robertson (Brian Compton, personal communication, 1988), a special digging stick was used to dig up wood fern rootstocks. It was similar

FIG. 3.—*Dryopteris expansa,* rootstock and fronds, taken at Bella Coola, and identified by several Nuxalk elders as the edible type of wood fern (left).
FIG. 4.—Cross-section of *Dryopteris expansa* rootstock (right).

to the stick used for other edible "roots," but shorter (about 30–45 cm long) and with a flattened point and a round portion on the upper end similar to a nail head. The stick, called ***cagàyu*** in Haisla, was pushed into the ground with the foot and then pressed down like a lever to remove the root from the soil. Recently, a shovel would be used for this purpose. Boas (1921) also reports the use of a digging-stick, of yew-wood, for prying up the fern rootstocks, which were then placed into a large basket. The Tanaina generally obtain wood fern rootstocks by chopping them out of the ground with an axe (Kari 1987).

Harvesting and cooking of the wood fern rootstocks, like the harvesting of most plant foods, was apparently undertaken mainly by women (cf. Boas 1921), but men also dug them ('Ksan, People of 1980).

*Storage.*—Harlan Smith (unpublished notes, ca. 1920) maintained that wood fern rootstocks ". . . were always cooked [by the Carrier and Nuxalk (Bella Coola)] the same day they were gathered. They were never kept." Morice (1893) noted that the rootstocks were not dried, but only eaten fresh after pit-cooking. Once cooked and mashed, the food only kept one or two days, according to Smith's Carrier consultant.

The Wet'suwet'en evidently gathered fern rootstocks for storage as well as harvesting them if needed after snow was on the ground. Elsie Tait of Hagwilget stated:

> In the old days [the women] would get together and leave Hagwilget to go up to Blue Lake. Above Blue Lake . . . they would dig a whole bunch [of fern rootstocks]. Then they would build fires. . . . They would put the fruit [rootstocks] under the rocks to cook it. They would preserve it for the winter. They lined cedar boxes with skunk-cabbage leaves *[Lysichitum americanum]* and preserved all that fruit in there. They sealed the boxes up and dug the ground like cellars. . . . They would preserve all those things for winter, put them away and save them until the hungry time [late winter]. (personal communication to LMJG, 1986).

The Haisla of Kitamaat Village also formerly stored fern rootstocks for winter. Gordon Robinson recounted:

> In the old days each family would pick ten sacks, or baskets of ***t'ibam*** [fern rootstock]. They would bury it in the corner of the long house. Like a root cellar. They break the base off. It is a useless part. They pick it in the fall . . . (personal communication to LMJG, 1988).

The Kwakwaka'wakw (Southern Kwakiutl) spread wood fern rootstocks out to dry on a mat the day after they were harvested, then cleaned them using a special red-cedar-wood scraper, and stored them in a basket in the rear of the house, behind the fire, for 12 days before they were pit-cooked. After they were cooked, they were stored another four days before being served at a feast (Boas 1921). The Mainland Comox also stored them prior to cooking in a cool, dry place, in an open-work basket (Randy Buchard, unpublished notes, 1973)[22]

The Gitksan, too, commonly store edible fern rootstocks. After they were dug, they might be left in a dry shed or cabin, covered with brush and leaves, for a long period of time, "when other food supplies ran out" ('Ksan, People of 1980:79).

In Alaska, Tanaina people are said to preserve wood fern rootstocks by placing them in an underground cache or by storing them in oil or lard (Kari 1987). The Yakutat people also stored them in a pit cache, and in general stored them in a way similar to potatoes. They also keep well for several months in a refrigerator, according to Ray (ca. 1980).

*Traditional cooking and serving methods.*—Wood fern rootstocks were hardly ever eaten raw, although the Nuxalk people sometimes ate them raw as an antidote for shellfish poisoning.[23] Baking or steaming the rootstocks in a pit was by far the most common traditional method of preparation. Detailed published accounts of pit-cooking them are provided in Gorman (1896:78–79) and Boas (1921:518–523). In the former description, the Coast Tsimshian of southeastern Alaska placed the rootstocks in cooking pits interspersed with damp moss or kelp and cooked them overnight (about 14 or 15 hours). In Boas's Kwakwaka'wakw (Southern Kwakiutl) account, seaweed and hemlock branches *(Tsuga heterophylla)* were used to surround the rootstocks, which were also cooked overnight. Members of the household were asked abstain from sexual intercourse during the cooking time.

Similar descriptions of pit-cooking wood fern rootstocks are provided by many others (cf. Morice 1893; Boas 1921; Harlan I. Smith, unpublished notes on Carrier and Bella Coola, ca. 1920–22; Nancy J. Turner, unpublished notes on Haida, 1970, 1971; 'Ksan, People of 1980; Leslie M.J. Gottesfeld, unpublished notes on Gitksan, Wet'suwet'en, and Haisla, 1987, 1988; Jacobs and Jacobs 1982; Kari 1987). Gitksan elder Jeff Harris Sr. said that the rootstocks were arranged in the pit ". . . Just like putting apples" [placed upright, in growth position] and were covered with hemlock boughs (personal communication to LMJG, 1987). The Wet'suwet'en covered them with birch bark (Leslie M.J. Gottesfeld, unpublished notes 1987). The Tanaina sometimes wrapped them in birch bark for baking and covered them with hot sand (Kari 1987). Haisla people used to cover the rootstocks with hot embers of a fire and leave them to bake overnight (Gordon Robinson, personal communication to LMJG, 1988). The Haida used to line their steaming pits with skunk-cabbage leaves. The Carrier were said to use alder bark chips in the steaming pit (Morice 1893). The Mainland Comox cooked the rootstocks they call ***th'ékwa*** (identified as *Athyrium filix-femina;* R. Bouchard Coll. No. 44 and No. 004; May 1975, May 1976 V) in a pit, but simply by throwing them directly into a bed of glowing hot coals and ashes from a fire and covering them with several inches of ashes (Randy Bouchard, unpublished notes on Mainland Comox ethnobotany, personal communication 1973, 1975 to NJT). In recent times, people have boiled the rootstocks in water for a long time, until they are tender; sometimes the water is changed during boiling (Kari 1987). One Hydaburg woman suggested pressure cooking them to reduce the cooking time (Ray ca. 1980). In Bella Coola today, pressure cooking is the method of choice for preparing wood fern rootstocks for feasts. The use of the rhizomes as a soup thickener was sug-

gested by Ray (ca. 1980). Some Gitksan people now preserve the rhizomes by canning ('Ksan, People of 1980). When not properly cooked, the rootstocks are described as rubbery and hard (Mark Jacobs Jr. of Sitka, personal communication to LMJG, 1988).

Boas (1921:523-524) provides a detailed description of the serving of wood fern rootstocks at a Kwakwaka'wakw (Southern Kwakiutl) feast, which was held four days after the fern roots had been in the house and had been cooked. The roots were considered a "really valuable food," and were often served with oil and dry silver-salmon spawn to the chiefs of the tribes. A chief could peel and eat the outer fern roots, but was supposed to give away the inner part of the fern root, not to eat it himself, or "he will always waver in his mind about giving away blankets . . ." After the feast, each guest was given two fern roots to take home to his wife.

There are many other reports of the rootstocks being cleaned, the leaf bases being removed, peeled, and eaten one at a time. Similarly, many reports refer to the eating of the rootstocks with oil, grease, lard, and/or salmon roe (cf. Nancy J. Turner, unpublished notes on Haida, 1971; Turner 1973; Randy Bouchard, personal communication to NJT, 1973 for Mainland Comox; 'Ksan, People of 1980; Kari 1987; Brian Compton, personal communication to NJT, 1988, for Haisla; Leslie M.J. Gottesfeld, unpublished notes on Gitksan, Haisla 1987, 1988). The Haisla, for example, ate them mixed with *ooligan* grease in a big bowl (Brian Compton, personal communication to NJT, 1988, from Gordon Robertson), or ate them with fermented or dried salmon roe (Gordon Robinson, personal communication to LMJG, 1988). The leaf bases, once removed from the main rootstock, were usually peeled with the fingers before being eaten, then dipped into the oil. The Mainland Comox dipped them into seal oil and ate them with dried salmon eggs (Randy Bouchard, unpublished notes on Mainland Comox ethnobotany, personal communication to NJT 1973, 1975). The Nuxalk ate them with grease or fermented salmon roe (McIlwraith 1948; Turner 1973). In modern times, the Gitksan ate them with sugar ('Ksan, People of 1980).

Kari (1987) notes that some Tanaina people state that only the "stem" portion of the underground part is eaten, others that only the "leaf bases" are eaten, and still others that both parts of the rootstock are eaten. Gitksan consultants say both "stem," and "leaf bases" can be eaten.

The Carrier, after pit-cooking the rootstocks, pounded them up with two stones, the upper one apparently a pestle, and the lower one flat (Harlan I. Smith, unpublished notes on Carrier and Bella Coola, ca. 1920-22). Smith noted that "Sometimes the Ulkatcho Carrier Indians went to Bella Coola and traded moccasins for pestles and other kinds of goods . . ."

Oswalt (1957) reported that the rootstocks of "*Dryopteris austriaca*" were occasionally collected, boiled in water, and added to ***agútuk***, or "Eskimo ice cream."[24]

Sometimes the rootstocks were simply roasted in the fire, covered with a hot stone, if there were not enough to pit-cook ('Ksan, People of 1980).

*Other food uses.*—The Tanaina and other southeast Alaskan natives eat the young croziers, or "fiddleheads" of wood fern (***uh***), cooked or steamed, as an early spring

vegetable, and many southeast Alaskans can them for winter use (Kari 1987; Heller 1976). The Kaigani Haida are said to boil and eat the "fiddleheads" (of "*Thelypteris*"; see Table 1) as a vegetable at present (Norton 1981). According to Ray (ca. 1980), fern fiddleheads, commonly eaten among many Native peoples of Alaska today, are not known to be a traditional food. He provides recipes and suggested methods for canning and freezing these greens. Some Tanaina people also used wood fern rootstocks for making beer, a practice they probably learned from the Russians, according to Kari (1987).[25]

*Survival and famine food.*—As recounted by Peter Kalifornsky of the Outer Inlet Tanaina (Kari 1987:130), the rootstocks were formerly regarded as a good survival or starvation food:

> In the early spring one year, the people ran out of food. They divided into two groups, one moving up into the higher country to dig ***uh*** [Tanaina name for edible wood fern; see Table 1], and the other to dig clams. Those people who lived on ferns received back their strength and gained weight, while those that lived on clams barely survived.

In winter and early spring, the rootstocks had to be chopped out of the ground, after a fire was first built over an area where the ferns were known to grow in order to thaw the ground (Kari 1987). The Tlingit (Jacobs and Jacobs 1982) and Gitksan ('Ksan, People of 1980) also state that wood fern can be a survival food: "It has warded off starvation more than once." ('Ksan, People of 1980:79). Mark Jacobs Jr. of Sitka (personal communication to LMJG, 1988) stated that perhaps fern rootstocks were eaten sometimes as an ordinary food, but they were mainly used as a survival food by the Tlingit. Gitksan and Wet'suwet'en stories also refer to fern rootstocks as a survival food. A woman who was banished from Moricetown survived through the winter on fern rootstocks and salmon roe according to a Wet'suwet'en story (Alfred Joseph, personal communication to LMJG, 1986). Jeff Harris Sr. mentioned a Gitksan legend about a period of starvation: "There in the famine some people eat ***aẍ*** [fern rootstock]. They lived. Others go to get ***xsu'u*** [hemlock cambium] but they all died." (personal communication to LMJG, 1988).

*Use frequency and taste appreciation of wood fern rootstocks.*—An interview study of 61 adult Nuxalk women in three generations, representing the Nuxalk reserve in Bella Coola, was conducted in 1982 as part of the Nuxalk Food and Nutrition Programme. Each woman was asked for her family's use for wood fern "root" (and other traditional food species as well), and a score of her impression of her own personal taste appreciation of the cooked root "fingers." Of the 61 women, only six (all elders) reported ever tasting the root food. On a scale of 1.0 (not used) to 4.0 (used more than one time per week when available and in season), the women reported a mean use frequency today of only 1.3 (very low) but in their earlier days they used it to a greater extent, with a score of 2.8 on a scale of 1.0 to 4.0, which represents use of approximately once or twice a month. These women reported never to have preserved or stored the roots (in cellars or otherwise) for later use.

The mean taste appreciation score of the six women was 4.3, in a scoring scale of 1 to 5, with 5.0 being the highest possible (best tasting food), indicating these women enjoyed this food. Details of the methodology are reported elsewhere (Kuhnlein 1989a).

Gorman (1896:79) described the taste of wood fern rootstocks as, ''slightly sweetish'' but ''too smoky and tobacco–like in flavor for the average white man's palate, except under stress of hunger.'' He added, ''. . . I have no doubt it is quite nutritious.'' The Tanaina also considered ***uh*** to be very nourishing, as indicated from their previously related use as a survival food (Kari 1987). Jacobs and Jacobs (1982) describe the edible portion as being ''light brown like squash and tastes about the same.'' Haida elder Willie Matthews described the cooked ''fingers'' (leafstalk bases) as ''just like potatoes inside'' (Nancy J. Turner, unpublished notes, 1971). Ray (ca. 1980) noted that the raw rhizomes of the wood fern (''*Dryopteris dilatata*'') are bitter, but sweet tasting when cooked. He said they are salmon colored, with texture and taste very similar to sweet potato. The Gitksan people also describe the edible fern as having the same texture and color as a sweet potato when cooked, and believe it to have ''considerable food value'' ('Ksan, People of 1980:79). One Lillooet elder described the taste as ''very much like coconut'' (Randy Bouchard, personal communication to NJT, 1974).

*Nutrient analyses*.—During the late summer and early fall of 1982, in the course of a general series of analyses of traditional foods carried out under the Nuxalk Food and Nutrition Programme, approximately 30 wood fern rootstocks were dug with the supervision of Nuxalk elder Felicity Walkus. These were cleaned in the traditional manner by washing with water and then (for convenience) cooked by pressure cooker until soft. The cooked roots were then peeled, and 250 g were frozen together in a plastic bag and shipped to the laboratory. A similar sample was prepared in 1983.

The laboratory samples were mixed with equal weights of distilled, deionized water, blended in a glass container with stainless steel blades and processed through various nutrient analyses. The details of these methods are reported in Kuhnlein et al. (1982) and Kuhnlein (1989a, 1989b).

Results of the nutrient analyses of the wood fern ''root'' samples are presented in Table 2, together with reported values for the common potato, baked in the skin. It can be seen that there is reasonably good agreement between the two foods for water, protein, ash, carbohydrates (computed by difference between total weight minus the sum of protein, fat, moisture, fiber, and ash) and approximate energy computations. In contrast, mineral values in fern ''root'' were much higher for calcium, magnesium, zinc, copper, and manganese, but higher in potato for sodium and iron. The differing values may have been in part due to contributions from the skin of the roots, since it is known that skins of root foods are more mineral–rich than the starchy flesh. These minerals can migrate into the flesh during cooking.

The proximate composition of fern ''root'' is in good agreement with that reported for *Trifolium wormskioldii* (springbank clover rhizomes) and *Potentilla anserina* ssp. *pacifica* (Pacific silverweed roots) (Kuhnlein et al. 1982). For mineral composition, fern ''root'' was slightly higher in calcium, phosphorus, and

TABLE 2.—Nutrients in cooked fern root *(Dryopteris expansa)* in comparison to cooked potato, per 100 g edible portion.

| Nutrient | Fern Root* | Potato** |
|---|---|---|
| Water, g | 68.4 | 71.2 |
| Protein, g | 2.5 | 2.3 |
| Fat, g | 1.0 | 0.1 |
| N.D. Fibre, g | 3.7 | n.a. |
| Ash, g | 0.8 | 1.2 |
| Carbohydrate, g | 23.6 | 25.2 |
| Calcium, mg | 56.3 | 10.0 |
| Phosphorus, mg | 62.6 | 57.0 |
| Sodium, mg | 1.4 | 8.0 |
| Magnesium, mg | 44.4 | 27.0 |
| Iron, mg | 0.8 | 1.4 |
| Zinc, mg | 1.5 | 0.3 |
| Copper, mg | 1.5 | 0.3 |
| Manganese, mg | 3.2 | 0.2 |

*n = 2 independent samples, analyzed in triplicate.
**Watt and Merrill (1975:106), potatoes baked, flesh and skin, n = 12.

magnesium. However, fern root contained zinc, manganese, and copper (1.5, 3.2, and 1.5 mg/100 g respectively) at least an order of magnitude higher than that found in silverweed roots, clover rhizomes, or potato (ranging from 0.2 to 0.8 mg for these three minerals in the three foods).

While nutritionally essential minerals are important to consider in these root foods, it must be kept in mind that the majority of minerals in the traditional diet are provided on a year round basis in fish and game. In contrast to these animal foods, the roots provide a minimal proportion of daily mineral needs.

In general, the ethnographic accounts give the impression that wood fern rootstocks were always an occasional food, used seasonally, prepared for feasts, or prepared for a taste treat. It was also quite labor-intensive for harvesting, pit-cooking, and peeling of the small "fingers" before eating. With these considerations in mind, one has to assume that fern rootstocks did not contribute a major proportion of the bulk, or of the energy value of the annual diet. Rather, they contributed variety and aesthetic values, and could be relied on as a famine food, since the ferns were accessible even in winter to those who knew where to look for them.

*Medicinal uses of wood fern and related types.*—A significant use by the Nuxalk of *Dryopteris expansa* (*"Aspidium cyclosorum"*) was eating the rootstock raw to neutralize poisoning from eating several kinds of shell-fish in the early part

of the summer (presumably paralytic shellfish poisoning, but not proven as such) (Smith 1928). The physiological basis for this application is not clear. Possibly, the information relates to the use of *Dryopteris filix-mas* rootstocks as an anthelmintic or vermifuge drug (Claus et al. 1970). Incidentally, we could find only one reference to use of a fern as a vermifuge by Native peoples in the study area: Smith (1928) noted that the Northern Carrier boiled the root of a fern (''species uncertain'') and drank the decoction for worms.

Most other medicinal uses of wood fern and its relatives were as poultices for skin ailments. The Clallam of Washington pounded the roots of *''Dryopteris austriaca''* and used the pulp as a poultice for cuts (Gunther 1973), and the Inland Tanaina boil the rootstocks of ***uh*** (apparently including both *Dryopteris expansa* and *Athyrium filix-femina)* in water and use the liquid as an eye wash and as a wash for cuts. The decoction is also drunk for tuberculosis, kidney troubles, and respiratory problems such as asthma (Kari 1987). The Haida used the boiled, mashed rootstocks of sword fern *(Polystichum munitum)*, which were called by the same Haida name as *''Dryopteris austriaca''* by several Native consultants, as a poultice for cuts and swellings (Nancy J. Turner, unpublished notes, 1971).

*Other, miscellaneous uses.*—The thin, wiry roots of *''Dryopteris austriaca''* were sometimes used by the Kwakwaka'wakw (Southern Kwakiutl) as the burning material in a ''slow match.'' They were enclosed within a clam or mussel shell and ignited. The shell could then be buried and the fern roots would smoulder for several days (Turner and Bell 1973).

The Upriver Halkomelem people sometimes gather the fronds of the ''mountain fern'' *(Dryopteris* sp.) for use by florists (Galloway 1982). The Western Eskimo of Alaska have used the fronds of *''Dryopteris austriaca''* in recent years to decorate the inside of the church and the graves in the cemetery on certain church holidays. Additionally, ferns were described as having adorned some of the ceremonial masks used by the Kodiak Island Eskimos (Oswalt 1957).

Gunther (1973) notes that the Snohomish (Lushootseed) soaked the leaves of *Dryopteris austriaca* for a hair wash. The Haida used the dried fronds for bedding and to inter–layer between drying fish to prevent molding (Nancy J. Turner, unpublished notes, 1971).

*Mythology and traditional beliefs.*—Edible wood fern is featured in several myths within the areas where it was used. There are at least two myths explaining the origin of this food, one Tlingit and one Lower Lillooet. In the Tlingit account, the head of an orphan girl entrapped by a landslide near her village was transformed into a fern root (***k!wAɬx***), while her body became a ground hog (marmot) (Swanton 1909:180).[26] In the Lillooet episode, part of a much longer, more complex story called ***Kaiyám***, a blind old woman was transformed into a wood fern plant by her angry husband because she had allowed their grandson to be stolen. He took her up and jammed her nose into a log, saying . . ., ''There! You shall become a ***Tsúkwa*** [wood fern]. By and by people will eat you . . .'' (Hill-Tout 1905:177).[27]

There are two other short episodes in Tlingit mythology concerning the wood fern. One is about its transformation by Raven, told within a long story of how Raven changed people, animals, and plants into their present form (Swanton 1909:18). The other is about a man who was aided in becoming a hunter by a supernatural mountain being. The man was warned that the green fern roots, which grow wherever there are grizzly bears, were not to be used because they belonged to the mountain being (Swanton 1909:358). Other mythical accounts of wood fern have not been previously published.

The following story about ***Sq'wâlm***, Wolverine, and Raven is shared in Kimsquit (Nuxalk, or Bella Coola) and Heiltsuk mythology, according to the late Margaret Siwallace, whose father, Joe Saunders, had told it to her around 1940:

> Wolverine went up to a certain mountain [above Kimsquit] to hunt for mountain goat. He was sitting by the fire roasting ***sq'wâlm*** on a stick when the supernatural being who is the "go-between" between mountain goat and people (he is half goat , half person, sort of like the mythical centaur) came along. "What are you doing?" he asked. Wolverine lied, "Roasting mountain goat kidney." Then the goat-person tested his bow. He shot in several directions and each time he shot a mountain goat. He peeled away the fat from around the stomach of each and gave it to Wolverine. Wolverine took it home and gave it to his children, who had a great time roasting it over the fire and eating it. Raven's children were nearby and wanted some, but they were not invited to eat. Wolverine told Raven how he got it.
>
> The next day, Raven decided to get some mountain goat fat for his children. He went up and was roasting some ***sq'wálm*** over the fire when the goat-person came. However, when he asked what he was doing, Raven answered the truth—roasting ***sq'wálm***. Goat-person did not test his bow and Raven got no mountain goat fat from him. He went down the mountain, wondering how he would feed his children. He slit his own breast open and removed the fat from his front. He gave it to his children telling them it was mountain goat fat. But when his children held it up to roast it, he kept calling, "It burns, it burns, it burns!" When they ate it, he still said that. (The late Margaret Siwallace, personal communation to NJT, 1983.)

According to Gitksan elder Jeff Harris Sr. people used to tell stories about fern root in the community house. He has given permission for the following story to be reported here, in his own words as told in English:

> There was a family of four: a man and his wife and two children. The older one was a girl and the small one a boy of three or four. When they ran out of food in the spring time there was still snow upon the "ravines." They used a wood paddle or shovel or spade, ***sin t'ul***, to scrape aside the snow [on the "ravine"]. They find ***ax̌***, The stems still come up under the snow. They gather it all up and roast it under fire.

The girl is looking after the little boy at the camp while the mother is [about 300 m] from the camp. The little boy cries. The girl is looking after the boy. The girl hollered to her mother, "The baby is crying." The mother replied, "Mi 'ooda lus todzin. Mi' 'ooda." She meant, put some ***aǎx*** in the ashes, prepare a bit of food for the boy.

The girl got it wrong and threw her brother in the fire. She hollers, "I threw him in the fire but he kept on coming back!" The boy got burned.

The story continues with an account of how a stranger dressed in black, a bear person, appeared and told the family how to use bear oil or fat on burns as an ointment or medicine. Harris explained that rendered bear fat could be used as grease when eating fern root, which may explain the linking of the story of the bear offering his fat to the eating of fern root.

The importance of wood fern rootstock as a winter food for the Gitksan is indicated by its adoption as a major crest by the house of ***Woxsimlaǎxhaa*** of the ***Gisq̇aast*** (Fireweed Phratry) from Kispiox. The crest is called ***Wii Aǎx*** ("giant wood fern rootstock"). It refers to a story about a giant wood fern root which was accidentally discovered near Kisgegas by a man after being mistaken for firewood. A large pile of wood had been gathered and burned all night. In the morning the giant ***aǎx*** was discovered in the ashes. (This may be a reference to the discovery of how to cook *Dryopteris* rootstocks.) The present holder of the crest is Alvin Weget of Kispiox village, who inherited the crest and a button blanket which displays the crest (Alvin Weget, personal communication to LMJG, 1988).

Photographs taken by Marius Barbeau (1929:86-87) show two totem poles from Kispiox village in the 1920s bearing the "mountain fern crest" ***(Wii Aǎx).*** The first (Fig. 5) shows a geometric pattern of diamonds purported to be the "mountain fern crest" ***(wii aǎx),*** ) probably the spiny wood fern. Modern residents of the village do not appear to recognize this crest. The second pole, still standing today (in a different location), stood beside the first, and figures the ***Wii Aǎx*** crest in more representational fashion: a series of upward pointing fingers in several tiers topped with four or five stylized fiddleheads (Fig. 6).

Boas (1932:227) reports a relevant traditional belief held by the Kwakiutl: "When fern roots *(Dryopteris spinulosa,* ***tsa'k'ŭs)*** are steamed in an oven, an immature girl, if possible the daughter of the woman who cooks the roots, must tramp on the mat to press the whole down firmly." In a previous description of pit-cooking the ferns (Boas 1921:521) he stated that the filled cooking-pit should be trampled by "a woman who has had just one husband, and whose husband is still alive, and who has never been a widow, and whose monthly period terminated at least eight days before." He also noted that all members of the household in which the fern rootstocks were being pit-cooked should abstain from sexual intercourse during the night.

## CONCLUSIONS

Although several different botanical identifications have been published for the edible wood fern rootstock, used as a food and emergency ration by Native peoples in western North America from Washington to Alaska, evidence sug-

FIG. 5.—Pole from Kispiox (''Kispayaks'') Village, showing at the base a geometric pattern of diamonds purported to be the ''mountain fern crest'' ***(Wii aǎ),*** probably *Dryopteris expansa* rootstock (left). Modern residents of the village do not appear to recognize this crest. FIG. 6.—Pole from Kispiox Village, showing the ***Wii Aǎ*** crest in more representational fashion: a series of upward pointing fingers in several tiers topped with four or five stylized fiddleheads (right).

Figure 5 photo by C.M. Barbeau, taken in 1920.
Courtesy of National Museums of Canada, Canadian Museum of Civilization, Ottawa, Ontario; Neg. No. 49285.
Figure 6 photo by Wilson Duff, taken in 1952.
Courtesy of the Royal British Columbia Museum, Victoria, British Columbia, pn No. 7037

gests that the major species involved was *Dryopteris expansa*, a member of the *Dryopteris austriaca* complex. Within this species, the largest specimens were preferred and selected. Other species with similar appearing rootstocks, including *D. carthusiana* and *D. filix-mas*, and *Polystichum munitum*, were also apparently eaten on occasion. Although *Athyrium filix-femina* has often been suggested as the edible wood fern, most knowledgeable Native elders who have examined its rootstock closely reject it as an edible type.

Present use of wood fern rootstocks as food is extremely low. In most cases, only Native elders in their sixties or older remember having eaten this food, or have themselves gathered and prepared it. A few elders are interested in obtaining and cooking it "for old time's sake," and to enjoy the remembered flavor. Everyone universally comments on the greater convenience and availability of substitute carbohydrate foods like potatoes and turnips. Some potential use for a survival food or an infrequently used cultural specialty food seems appropriate.

Because the distribution of the edible wood fern is scattered, and because harvesting the rootstock for food means destruction of the entire plant, conservation of wood fern populations should be a primary consideration in any program involving future food use of wood fern.

## NOTES

[1]J.P. Harrington's notes (ca. 1910) are at the Smithsonian Institution, Washington, D.C. (Reel 15, frame 0472). Ethnographer T.T. Waterman confirmed the same term for this fern about a decade later (Barbara Lane, personal communication to NJT, 1985).

[2]Four different unpublished manuscripts of Harlan I. Smith are cited. They contain unnumbered pages, many of which are duplicated under one or more different titles. Handwritten notes have been added to typed text with occasional dated entries. Comments on Pteridophyte data date mostly from 1920–1922. The original manuscripts are all held by the National Museum of Civilization in Ottawa, Ontario (formerly National Museum of Man), and are entitled: "The Material Culture of the Carrier Indians of British Columbia, Part 1. Introduction to Food Starvation;" "The Material Culture of the Carrier Indians of British Columbia, Part 2, Securing Food to Dwellings;" "The Uses of Plants by the Bella Coola Indians of British Columbia, Vol. 1;" and "The Uses of Plants by the Carrier Indians of British Columbia, Vol. 1." His Native consultants included Captain Schooner (Nuxalk, or Bella Coola speaker, born ca. 1848), Joshua Moody (Nuxalk speaker, born ca. 1868), Louie Hall, and "Pretty Charlie," (probably Ulkatcho Carrier speaker Charlie West). Voucher specimens made by Smith of the ferns mentioned in his notes are at the National Herbarium in Ottawa (CAN). They were examined by Adolf Ceska during the present research.

[3]The following unpublished notes on the Haida and Nuxalk made by Nancy J. Turner, and in her possession, are cited in the manuscript: Turner 1970 (Haida), Turner 1971 (Haida), Turner 1981 (Nuxalk), Turner 1983 (Nuxalk), Turner 1988 (Nuxalk).

[4]Harlan I. Smith's unpublished notes, ca. 1921: "Lady Fern, *Asplenium cyclosorum*" (collections made by Smith: *8a* June 7, 1920 [CAN 525 607]; *8b* June 22, 1920 [CAN 525 608]); both were confirmed by Adolf Ceska as *Athyrium filix-femina)*.

[5]Harlan I. Smith's unpublished notes: "Shield Fern, *Aspidium spinulosum*" (collections made by Smith *7(54M)* June 18, 1921 [CAN 525 615], and *7(77M)* July 11, 1921 [CAN 525 616]. Both identified by Adolf Ceska as *Dryopteris expansa.)*

[6]Harlan I. Smith's unpublished notes: "*Aspidium filix-mas*" (Smith Coll. *7(55M)*, June 18, 1921 [CAN 539 343]; identified by Adolf Ceska as *Athyrium filix-femina,* but specimen is the top part of an old frond, easily mistaken for *Dryopteris filix-mas*—AC).

[7]This term, ***salídana***, is sometimes applied as a general term for ferns in North Wakashan languages such as Kwakwala (Southern Kwakiutl) and Haisla, or to *Polystichum munitum* specifically (cf. Turner and Bell 1973; Lincoln and Rath 1986; Brian Compton, personal communication to NJT, 1989).

[8]Two ferns, one called ***da sŭn a chŭn*** and one, ***ah, aŭ, ah chŭn,*** or ***aŭ chŭn,*** are mentioned in Harlan I. Smith's unpublished Carrier notes. The former term, listed under "Lady Fern (*Asplenium cyclosorum* Rupr.)," has a hand-written notation: "Leaves coarse and less bifurcated than the shield fern." The latter, under "Shield Fern," states: ". . . has spores and is finer and more bifurcated than *[Asplenium]* . . . This Shield fern roots used for food found 20 miles away [in the Bella Coola Valley] . . . roots called ***ah***. . . . it always has little [hairs?; can't read handwriting] like where branchlets come off stem . . . there are none on ***[da sŭn a chŭn]***." Smith noted that ***ah chŭn*** was the same as ***squalum*** in Bella Coola, but also reported that one of his Native consultants (H.I.S.) could not distinguish between the two types.

[9]Another aspect of the confusion is seen in Franz Boas's classic work, *The Ethnology of the Kwakiutl* (Boas 1921), where meticulously reported accounts are given in English and Kwakwala of the harvesting, preparation, and serving of Kwakiutl foods. Cultural features of at least three edible fern species are described, all called in the English version simply "fern-root:" bracken *(Pteridium aquilinum)*—***sāguma;*** licorice fern *(Polypodium glycyrrhiza)*—***ɬEk!wa$^{e}$yē***; and wood fern *(Dryopteris expansa,* or "*D. spinulosa*")—***tsāk•usē***. One must consult the Kwakwala text to learn which species is being discussed. In fact, in at least one case (Boas 1921: 526), the scientific identification for the fern being discussed, given as *Dryopteris spinulosa,* does not match the Kwakwala name used, ***ɬEk!wa$^{e}$yē***, and the information given also matches *Polypodium,* since it refers to the "fern-root" being held in the mouth of a hunter to alleviate hunger and thirst, a common practice for this latter species.

[10]A small, related species of rocky areas, *P. imbricans* (D.C. Eaton) D.H. Wagner, sometimes included as a form of *P. munitum,* extends in our area only to the eastern part of Vancouver Island and the Sechelt Peninsula; its rootstock is very small, and its use as food is unlikely.

[11]Another fern, whose fiddleheads were eaten by Native peoples of the Maritimes, *Matteucia struthiopteris* (L.) Tod. (ostrich fern), also occurs in some locations where edible wood fern rootstocks are used (i.e., Kispiox River and north of Kitimat) but its range is quite restricted, nor, to our knowledge, has it ever been cited in the ethnobotanical or ethnographic literature of western North America as having been eaten here.

[12]*Dryopteris fragrans* (L.) Schott. (fragrant shield fern or fragrant cliff fern) can be excluded from the species possibly used as food, because of its small size and its limited distribution on dry limestone cliffs in northern British Columbia and Alaska (cf. Scoggan 1978; Hultén 1968). *Dryopteris arguta* (Kaulf.) Watt (coastal shield fern) is likewise excluded

because it is restricted to southeastern Vancouver Island (near Nanoose Bay) and the adjacent Gulf lslands (Straley et al. 1985), whereas the major reports of use of edible wood fern are outside of this range. *Dryopteris cristata* (L.) A. Gray is a relatively rare species of the British Columbia interior, and has not been collected at all along the coast (Straley et al. 1985).

[13]Some authors, including Walker (1961), questioned correctness of the name *D. carthusiana,* but we followed the nomenclature suggested by Heywood (1964) and generally accepted in the recent pteridological literature (Page 1982; Lellinger 1985).

[14]In a taped interview with Nancy J. Turner, 1971. The ferns being discussed included *Athyrium filix-femina, "Dryopteris austriaca [D. expansa],"* *Adiantum pedatum,* and *Blechum spicant,* all of which George Young called, at times, ***djagwal.*** *D. expansa* was also called ***snándjang;*** *Pteridium aquilinum* he called ***snándjang-xil;*** and large specimens of *Athyrium filix-femina, Dryopteris expansa,* and *Polystichum munitum* were called ***tságwel,*** or ***skyaw*** (lit. "tail"), which he specified pertained to the larger, edible rootstocks. They are also sometimes called ***tanskyaw*** (lit. "black-bear's tail"). The smaller specimens of these species and *Blechnum spicant,* with rootstocks too small to eat, were sometimes called ***snal-djat*** (lit. "scabby-girl") (Florence Davidson and Willie Matthews, Masset speakers, in Nancy J. Turner unpublished notes, 1971).

[15]Margaret Siwallance used this term specifically to refer to the dead fronds of *Pteridium* (bracken fern), but recently she applied it to the dead fronds of any fern, or even dead leaves of any tree (Randy Bouchard, unpublished notes, 1974).

[16]Voucher specimens at Royal British Columbia Museum Herbarium: *Turner 1698*—V 127,877 *(Athyrium filix-femina)* and *Turner 1699*—V 127,878 *(Dryopteris expansa).*

[17]Voucher: *Turner 1592*—V 88,796, 88,798–9.

[18]The following unpublished notes made by Leslie M. J. Gottesfeld, and in her possession, are cited in the manuscript: Gottesfeld 1987, Gottesfeld 1988 (Gitksan).

[19]An additional fern to be found in the preferred habitat of ***ax̌,*** namely a mountain snow-bed or avalanche chute, is bracken *(Pteridium aquilinum).* This fern was distinguished by Jeff Harris Sr. and Billy Blackwater of Kispiox as being shoulder high and was called ***haba ba'a.*** Both ***haba ba'a*** and ***dumtx*** are said to have larger leaves than ***ax̌*** (Leslie M.J. Gottesfeld, unpublished notes, 1988). Voucher specimens of ***ax̌*** collected by Gottesfeld have not yet been accessioned at the Royal British Columbia Museum Herbarium (V), but all were identified or verified by Adolf Ceska, Jan. 30, 1989 as *D. expansa: TM 201, TM 202, Eth 25, Eth 29, Eth 30.*

[20]This information was mentioned elsewhere by Gordon Robinson in a handwritten manuscript, transcribed from a recording of a speech by him on Haisla culture, on file at the Native Indian Teacher Education Program Library, University of British Columbia, Vancouver (no date given).

[21]Various other Haisla and Heiltsuk terms relating to the edible wood fern were recorded by Brian Compton from Gordon Robertson. These include terms meaning "soft end of edible fern root," "to eat edible fern root," "to go after edible fern root" (all Haisla), and "to eat fern roots" (Heiltsuk). There are also terms (Haisla, ***k'àlak;*** Heiltsuk, ***k'álax, k'lk'áx)*** apparently referring to the fronds of wood fern, or "a long green fern species" (Lincoln and Rath 1986) which were used to cover salmon in a canoe to prevent them from drying out.

[22]Randy Bouchard, unpublished notes, 1973, 1975, British Columbia Indian Language Project, Victoria, British Columbia.

[23]Nancy J. Turner (1973; unpublished notes, 1983) reported that Margaret Siwallace stated that people wishing to lose weight ate wood fern rootstocks raw, but Harriet Kuhnlein, who also spoke to MS about this, felt that she meant the rootstocks took so much energy to find and dig out that by the time you got enough for a meal, you would lose weight. Kari (1987) (see section, *Survival and famine food)* implies that it is possible to *gain* weight from eating (cooked) fern rootstocks.

[24]This dish is made from seal oil and commercial lards mixed with berries, a little sugar, boiled fish, and certain greens such as sour dock, horsetail, mare's tail, or wood fern. In the winter it is stored in the cold so that the oils congeal, and it is served in a solid state. It is a favorite dessert at Napaskiak, and an adult usually will consume two to three measuring cups full at a sitting (Oswalt 1957).

[25]The beer, called ***uh biva,*** was made by mashing the rootstocks and cooking them for several hours in a gallon (5 l) of water. Hops were added, either before or after the rootstocks had finished cooking, and afterwards, a pound (0.5 kg) of sugar and a pound (0.5 kg) of mashed potatoes or raw cornmeal was added, followed by five more gallons (25 l) of water, and, finally, the yeast (this is one version of a rather variable recipe) (Kari 1987).

[26]Swanton noted "evidently fragmentary" for this myth.

[27]Hill-Tout (1905) identifies ***"Tsúkwa"*** only as "some kind of trailing plant or herb that grows on logs in the forest."

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## BOOK REVIEW

**Conservation of Medicinal Plants: Proceedings of an International Consultation.** Olayiwola Akerele, Vernon Heywood, and Hugh Synge (editors). Cambridge, United Kingdom: Cambridge University Press, 1991. Pp. xvi, 362. No price given (hardcover). ISBN 0–521–39206–3.

This impressive volume reports on the findings of an international meeting held in Chiang Mai, Thailand, from 21–27 March, 1988. Sponsored by the World Health Organization (WHO), the World Conservation Union (IUCN), and the World Wide Fund for Nature (WWF), it brought together experts from 16 countries to "exchange views on the problems, determine priorities and make recommendations for action" regarding the conservation of medicinal plants.

As is customary these days, the participants formulated a political call to action. Printed at the beginning of the book, The Chiang Mai Declaration calls on international agencies to "Save the Plants that Save Lives" by addressing the social and ecological deterioration that threaten plants used in health care.

The book is separated into six sections. The Introduction reviews the perspective on medicial plants taken by the sponsoring agencies. The Issue of Medicinal Plants contains papers by Farnsworth and Soejarto, Plotkin, and Schultes. Although these overviews provide a good introduction for novices, most of the programs, concepts, and references will be familiar to practicing ethnobotanists.

The section on Science, Industry, and Medicinal Plants begins with three technical papers that analyze economic aspects of plant conservation and management. A fourth paper describes recent advances in constructing information systems and databases. Written by Synge and Heywood, two leaders in the field, it contains useful suggestions on how to use computers to arrange research data.

The remaining three sections present the applied side of medicinal plant conservation—Techniques, Policies, and Experiences. Eighteen papers review diverse topics ranging from the role of agronomy, botanical gardens, and protected areas to political, legal, and educational aspects. Case studies focus primarily on Asia (Sri Lanka, Thailand, Indonesia, India, and Bangladesh), but examples are also given from Kenya, South Africa, and Peru.

As I read through the essays, I was struck by the continuing dichotomy between *in situ* and *ex situ* conservation. Although both will ultimately be needed in any campaign to preserve medicinal plants, this book reveals an ideological difference between one camp and the other. *Ex situ* conservation is expensive, requiring the backing of a governmental or international agency. Some of the methods that are encouraged—biotechnology (Palevitch; Schumacher), botanical gardens (Heywood; He and Cheng), phytochemical research (Husain), and commercialization (Principe; Bonati)—take the resources out of the hands of local producers.

Given the current interest in intellectual property rights (IRP), it is curious that Synge and Heywood's piece on information systems should be sandwiched between these papers on commercialization and biotechnology and not found among the case studies from the Third World. This may send the message that computer networking and information sharing will ultimately benefit industrialized countries, while giving little profit to the communities from which plants and ethnobotanical lore are gleaned. In sum, this set of papers would have been enriched by a greater emphasis on how technology can help indigenous peoples and developing nations maintain a stake in their cultural heritage and natural resources.

With the essay by McNeely and Thorsell on the role of protected areas in conserving medicinals, there is a shift in emphasis: peasants and indigenous peoples are back in the equation. The case study on *in situ* conservation in Sri Lanka (Lokubandara) demonstrates how medicinal plants can be restored to natural areas through an effort involving a large sector of the population. A companion essay (de Alwis) shows how *ex situ* conservation supports this initiative.

The volume is fittingly brought to a close with a case study from South Africa (Cunningham) that exemplifies how theory and methodology from the field of

resource management can be applied to conservation of plant populations. This approach gives us the tools necessary to evaluate the status of medicinal plants in the wild and to propose alternative management methods that are acceptable to local people.

When I closed the book after reading the parting words of the WHO program manager for traditional medicine, Olayiwola Akerele, I found myself reflecting on the speed with which things are changing. In the three and a half years since the meeting was convened, the agenda advocated by the conference participants has been widely accepted and implemented in some countries. At the same time, the world ecological and social situation is increasingly dire. I recommend this volume to anyone who wants to join the battle for indigenous rights and natural conservation.

Gary J. Martin
Anthroplogy Department
University of California
Berkeley, CA 94720

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# INFLUENCES OF MID-HOLOCENE ALTITHERMAL CLIMATES ON MAMMALIAN FAUNAS AND HUMAN SUBSISTENCE IN EASTERN WASHINGTON

R. LEE LYMAN
*Department of Anthropology*
*200 Swallow Hall*
*University of Missouri-Columbia*
*Columbia, Missouri 65211*

ABSTRACT.—Palynological data indicate climates in eastern Washington between 8000 and 4000 B.P. were warmer and drier than before or after that time. It has been hypothesized that this mid-Holocene warm-dry interval, typically called the Altithermal, would have resulted in decreased mammalian biomass and prompted prehistoric hunter-gatherers in eastern Washington to shift subsistence pursuits to focusing on fish and plants, increasing reliance on small mammals, a broader range of mammalian taxa being exploited, or some combination of these. Mammalian faunal data compiled from 11 sites in one area and 28 sites in another area do not conform with these hypotheses. Small mammals used as food resources decrease in relative abundance continuously through the last 10,000 years in both areas, fish remains are more abundant after 4000 B.P. than before that time in one area, and ungulates steadily become more abundant over the last 10,000 years in both areas. Indications of natural faunal turnover are masked by sample size effects, and shifts in mammalian biomass are obscured by varying intensity of human occupation.

RESUMEN.—Los datos palinológicos indican que, entre 8000 y 4000 años antes del presente, el clima en el este del Estado de Washington (Estados Unidos de Norteamérica) fue más cálido y más seco que antes o después de dicho tiempo. Se ha aventurado la hipótesis de que este intervalo caliente y seco de mediados del holoceno, llamado tipicamente el altitermal, habría resultado en una biomasa reducida de mamíferos y habría provocado que los cazadores-recolectores en el este de Washington modificaran su subsistencia para enfocarse en peces y plantas, incrementar su dependencia de mamíferos pequeños, explotar un rango más amplio de taxa de mamíferos, o alguna combinación de estas posibilidades. Los datos compilados sobre mamíferos de 11 sitios en un área y 28 sitios en otra, sin embargo, no concuerdan con estas hipótesis. La abundancia relativa de mamíferos pequeños usados como alimento disminuye continuamente durante los últimos 10,000 años en ambas áreas, los restos de peces son más abundantes despues de 4,000 años antes del presente en un área, y los ungulados se vuelven más y más abundantes a lo largo de los últimos 10,000 años en ambas áreas. Las evidencias de la rotación natural de existencias de fauna son disfrazadas por efectos del tamaño de las muestras, y los cambios en la biomasa de mamíferos son oscurecidos por la intensidad variable de la presencia humana.

RÉSUMÉ.—Les donneés palynologiques indiquent que les climats dans l'Est de Washington, entre 8000 et 4000 B.P. etaient plos chauds et secs qu'arant et oprés cette période. On a proposé que cet interval chaud et sec du Moyen Holocène, l'Altiehermal, aurait pu déclancher un déclinement de la faune mammifère. En conséquence, les chasseurs collecteurs préhistoriques de l'Est de Washington auraient modifier leur existence en diminvant l'importance des grands mammifèrs et en accentuant l'importance du poisson, des plantes, et des petits mammifèrs, ou un plus grand rayon d'exploitation de types de mammifères, ou pent-être une combination de ceux-ci. Les donne'es recueillies peur la faure mammifère de 11 sites dans une région et 28 sites d'une autre région ne supportent pos ces hypothèses. Les petits mammifères utilizés comme denrée alimentaire diminuent continuellement en abendance relative pendant les dernieres 10,000 années pour les 2 régions. Les restes de poissons sont plus abondants après 4000 B.P. dans une région, et les ongulés augmentent constament pendant les dernieres 10,000 années dans les 2 régions. Les indications de renversements de faune naturels sont masquées par les petites dimension des groupes étudiés, et les changements de faune mammifère sont voilés par les variations dans l'intènsité d'occupation humaine.

## INTRODUCTION

Palynological data for Holocene deposits in eastern Washington (summarized in Barnosky et. al. 1987; Mehringer 1985) suggest that climates 10,000 years ago were cooler and moister than at present. Evidence of increased aridity appears as early as 9000 B.P. or slightly later. Maximal aridity seems to have occurred between approximately 8000 B.P. and 5000 to 4500 B.P. during the climatic interval called the Altithermal, with essentially cooler and moister to modern conditions prevailing after 4000 B.P. Potential impacts of the mid-Holocene warm, dry climatic interval on human occupants of the area have long been the subject of discussion (e.g., Baumhoff and Heizer 1965; Bense 1972). Fryxell and Daugherty (1963:14) suggested large game would decrease in abundance and force prehistoric peoples to rely on fishing and gathering rather than hunting during the mid-Holocene. Schalk (1983:145) argued xeric climatic conditions would decrease ungulate biomass due to decreased biomass of forage and "would probably exclude ungulates other than pronghorn *(Antilocapra americana)*" from the more xeric areas of eastern Washington (see Van Vuren 1987 for similar arguments concerning bison *[Bison bison]*).

Previous studies of the mammalian history of eastern Washington indicate some taxa apparently responded to climatic change during the Holocene by modifying their distributions (Lyman 1986a, 1986b, 1991a, 1991b; Lyman and Livingston 1983; McCorquodale 1985). Other studies suggest changes in relative taxonomic abundances occurred during the Holocene (Gustafson 1972; Van Vuren 1987). Research at Marmes Rockshelter (site number 45FR50) suggested to Gustafson (1972:105) that mammalian faunas in eastern Washington remained taxonomically stable throughout the last 8000 years. He detected an increase in the abundance of large mammals during the Altithermal occupation of Marmes Rockshelter which he felt resulted from the fact that the faunal remains were humanly deposited

and thus reflected both the number of animals killed for human consumption rather than natural biomass, and a mid-Holocene increase in human occupational intensity of the site. In this paper I review the known Holocene record of mammals in two geographically distinct areas of eastern Washington in an attempt to find evidence of changes in the mammalian fauna and the contribution of that fauna to human subsistence. Simultaneously I search for sample-size effects as it has been well documented that sample size can adversely influence the measurement of faunal turnover (e.g., Badgley and Gingerich 1988; Koch 1987) and estimates of faunal biomass (e.g., Grayson 1984). I also monitor the intensity of human occupation because increases in such occupation could result in higher rates of deposition of animal remains in sites.

## STUDY AREA, MATERIALS, AND METHODS

The Columbia Basin of eastern Washington is diverse physiographically and vegetationally (Franklin and Dyrness 1973) and contains several vegetation zones that Daubenmire (1970) has characterized generally as steppe. Mean annual precipatation is 20 cm in the southern (Lower Snake River) part of the basin and 33 cm in the northern (Upper-Middle Columbia River) part (Fig. 1). Mean temperature in January is –5° C in the southern part and –9° C in the northern part; mean temperature in July is about 32° C in the southern part and 30° C in the northern part.

To date, few data on the Holocene mammals of eastern Washington have been derived from natural bone accumulations such as natural traps, carnivore dens, or raptor or owl roosts. The single such studied fauna was recovered from deflated areas in a dune field and is of unclear but probably late Holocene age (Miller 1977). Well over 95% of the available mammalian data derive from archaeological sites that have been excavated by numerous individuals over the past 35 years. Because humans were responsible for selectively accumulating and depositing many of the bones in such sites, care is warranted when attempting to derive paleoenvironmental meaning from these bone assemblages. The sites I have used in this analysis are, with one exception (Marmes Rockshelter), open sites, but some are villages (i.e., have clear evidence of substantial structures) while others appear to be camps (i.e., lack evidence of structures), suggesting between-site variation in season of occupation, duration of occupation, or both. Assemblages of artifacts and plant remains indicate that activities performed by human occupants of the sites were similar but not identical, with some between-site variation in resources procured, procurement techniques used, and resource processing. Geological data indicate between-site variation in postdepositional histories of the faunal remains. On one hand, these data indicate that while interpretation of the mammalian fauna from a single site might be significantly influenced by the human activities and postdepositional proccesses that, respectively, produced and affected the faunal remains, summing the faunas from a series of sites should serve to mute such influences and produce a general indication of trends in the natural faunal history of the area (Lyman 1987). On the other hand, the muting effects of summing multiple archaeological faunas will produce only general indications of trends in human subsistence pursuits,

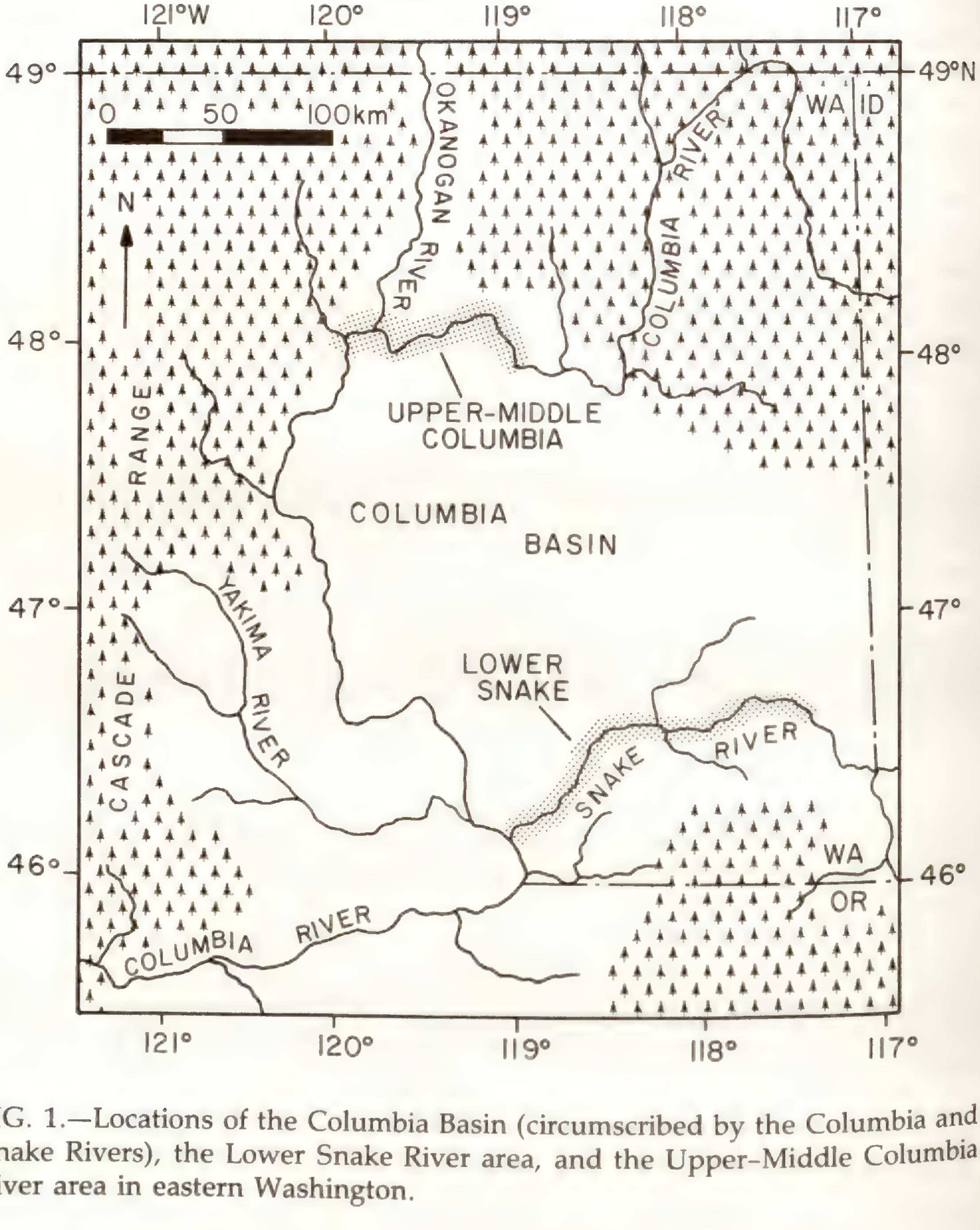


FIG. 1.—Locations of the Columbia Basin (circumscribed by the Columbia and Snake Rivers), the Lower Snake River area, and the Upper-Middle Columbia River area in eastern Washington.

given that some sites seem to have been occupied by humans that were more specialized in subsistence pursuits than the occupants of other sites. This seems preferable to site-specific studies at this time; once general trends are established in both the cultural or subsistence pursuits of people and the natural faunal history of the area, site-specific faunas from both cultural and natural deposits can be used to fine-tune the trends indicated.

Data were compiled from published and unpublished archaeological reports for two areas: the western two-thirds of the Lower Snake River, and the Wells Dam Reservoir and Chief Joseph Dam Reservoir areas of the Upper-Middle

Columbia River (Fig. 1). These two areas were chosen for study because the former is the geographic location from which data leading to discussions of Altithermal-induced faunal change originated, and the latter area contains the largest sample of mammalian remains of any area in eastern Washington similar in geographic size to the Lower Snake River area.

Mammalian faunal data from 11 archaeological sites along the lower Snake River and 28 archaeological sites along the Upper-Middle Columbia River were compiled (Tables 1 and 2). Data from the former 11 sites span the last 10,000 years while data from the latter 28 sites span the last 7000 years. Well over half of the Upper-Middle Columbia River data derive from the Chief Joseph Dam Reservoir area. These data were originally reported by three temporal periods: 7000 to 4000 B.P., 4000 to 2000 B.P., and 2000 to 100 B.P. (see Livingston 1985 for a summary of the data). Thus I tallied all other faunal data for this area by those three temporal periods despite the fact that many of these data had been assigned to much briefer temporal spans (Chatters 1984a, 1984b, 1986; Lyman 1988). I tallied the Lower Snake River data by 2000 year increments for the entire Holocene to make them readily comparable to those from the Upper-Middle Columbia River area. While such arbitrary definitions of temporal periods may mask significant turnover events or instances of fluctuating biomass (e.g., Peterson 1977; Schindel 1980), by lumping site-specific samples I hoped to eliminate sample size-effects such as larger samples typically being taxonomically richer than smaller samples.

TABLE 1.—Sample size (number of identified specimens [NISP]) per time interval and site in the Lower Snake River area.

| | Years B.P. | | | | | |
|---|---|---|---|---|---|---|
| Site | 10,000–8000 | 8000–6000 | 6000–4000 | 4000–2000 | 2000–100 | Reference |
| 45FR50 | 289 | 269 | 158 | 57 | 57 | Caulk 1988; Gustafson 1972 |
| 45WT2 | | 42 | 17 | 17 | 38 | Gustafson 1972 |
| 45CO1 | | 44 | | 222 | | Bense 1972; Nelson et al. 1968 |
| 45GA61 | | | | | 648 | Lyman, unpubl.[1] |
| 45WT39 | | | | | 808 | Yent 1976 |
| 45GA17 | | | | 571 | | Lyman, unpubl.[1] |
| 45WT41 | 324 | 41 | 161 | 65 | | Gustafson 1972 |
| 45FR36 | | | | 53 | | Schalk 1983 |
| 45FR5 | | | | | 4,749 | Schalk and Olson 1983; Olson 1983 |
| 45FR40 | | | | | 35 | Kenaston 1966 |
| 45WT134 | | | | 283.5 | 296.5 | Lyman 1990 |

[1]Unpublished lab data in possession of the author.

TABLE 2.—Sample size (number of identified specimens [NISP]) per temporal interval and site in the Upper–Middle Columbia River area.

| | Years B.P. | | | |
|---|---|---|---|---|
| Site | 7000–4000 | 4000–2000 | 2000–100 | Reference |
| 45DO189 | | 452 | | Lyman 1988 |
| 45DO190/191 | | 109 | | Chatters 1984b |
| 45DO204 | 31 | | | Livingston 1985 |
| 45DO211 | | 479 | | Livingston 1985 |
| 45DO214 | | 189 | 400 | Livingston 1985 |
| 45DO242 | | 609 | 50 | Livingston 1985 |
| 45DO243 | 53 | 94 | | Livingston 1985 |
| 45DO273 | 48 | | | Livingston 1985 |
| 45DO282 | 426 | | | Livingston 1985 |
| 45DO285 | | 326 | 196 | Livingston 1985 |
| 45DO326 | 283 | 79 | 276 | Livingston 1985 |
| 45DO372 | | 496 | 42 | Chatters 1986 |
| 45DO394 | | 31 | | Chatters 1984b |
| 45OK2 | | 661 | 1401 | Livingston 1985 |
| 45OK2A | 45 | 294 | | Livingston 1985 |
| 45OK4 | 131 | 790 | 97 | Livingston 1985 |
| 45OK11 | 3,034 | 540 | | Livingston 1985 |
| 45OK18 | | 31 | | Livingston 1985 |
| 45OK69 | | 104 | | Chatters 1986 |
| 45OK165 | | 31 | | Chatters 1984b |
| 45OK197 | | | 1253 | Chatters 1984b |
| 45OK207 | 105 | | | Chatters 1984b |
| 45OK208 | 68 | | | Chatters 1984b |
| 45OK250 | 213 | 666 | | Livingston 1985 |
| 45OK258 | | 2,332 | 1,986 | Livingston 1985 |
| 45OK287/288 | 182 | 451 | 200 | Livingston 1985 |
| 45OK382 | 50 | | | Chatters 1986 |
| 45OK383 | | 241 | | Chatters 1986 |

Taxonomic abundances were tallied as numbers of identified specimens (NISP). While there are sound theoretical reasons for using NISP rather than a different quantitative unit in my analysis (Grayson 1984), the practical reason is that quantitative data are only regularly reported in the form of NISP for the materials I analyze. It is difficult to estimate biomass directly from NISP values,

but traditional interpretations in the geographic area under consideration have used NISP as a fiat measure of animal biomass, and I follow that tradition here.

For both areas only temporally fine-scale assemblages that include more than 30 NISP were used to remove some of the effects of excessively small samples. The total NISP from a site might be 59, but if those specimens were stratigraphically distributed in such a manner that 28 specimens dated between 2000 and 1500 B.P. and 31 specimens dated between 3000 and 2000 B.P., generally only the latter 31 specimens were included in my analysis. By summing site-specific data within each area, I hoped to compile an area-specific faunal history for both areas and to avoid the effects of site-specific depositional hiatuses and temporally fine-scale but small assemblages on my analyses. In a few cases site-specific faunal assemblages span time periods greater than 2000 yr or overlap a temporal boundary. For example, one stratigraphically defined faunal assemblage was dated between 5000 and 3000 B.P. This assemblage was simply halved, with exactly half the NISP per taxon being tallied for the 6000 to 4000 B.P. period and the other half being tallied for the 4000 to 2000 B.P. period. Only one stratigraphically defined fauna (45WT2) that was split into two faunas, each with fewer than 30 NISP, was used in my analysis (Table 1).

I noted the temporal occurrence of each taxon represented at each site in both areas and compiled two tables, one for each geographic area (Tables 3 and 4). A taxon was deemed present for an entire temporal period if its remains dated to any part of that period. I then tallied the total NISP per taxon per area, the number of sites in which a taxon was found per area, the taxonomic richness per temporal period per area, and the total NISP per temporal period per area. Because zooarchaeological data are often at best ordinal scale (Grayson 1984), I use Spearman's rho ($r_S$) to assess the strength of correlations between selected pairs of variables.

Measures of human occupational intensity such as depositional rates of artifacts are only available for some of the sites I consider. I use such measures when available, and also use frequencies of radiocarbon dates and frequencies of dated sites as measures of occupational intensity. I fully realize such frequencies are at best indirect measures of human occupational intensity because frequencies of dates and dated sites often reflect an archaeologist's research design or preservation of dateable materials (Rick 1987). I therefore supplement these data when possible with information on sites dated by the presence of temporally diagnostic artifacts.

## HYPOTHESES AND IMPLICATIONS

Palynological data alone lead to the following hypotheses:

1) Animal biomass should be at its lowest level during the mid-Holocene of eastern Washington.

2) Ungulates such as bison, deer *(Odocoileus* spp.), wapiti *(Cervus elaphus),* and bighorn sheep *(Ovis canadensis)* should display their lowest abundance (and may not be present) during the mid-Holocene.

3) The number of taxa and the frequency of individual taxa, particularly those adapted to relatively moist conditions, should both be at their lowest levels during the mid-Holocene.

4) Changes in taxonomic composition through time should be contemporaneous with changes in climate. However, as noted, available faunal data are from archaeological contexts wherein the human selection of prey may significantly influence the faunal record. It is important, therefore, to consider the possible combined influences of human behaviors and increased aridity on faunal abundances.

*Human responses to climatic change.*—Resources can become scarce through an actual decrease in frequency or through the effect of increasing competition for resources as the relative frequency of predators/consumers increases. Ecologists believe that niche breadth tends to increase as resource availability decreases (Pianka 1978:256) and that when high-value prey are rare, diet expands to include more low-value prey (Pulliam 1981:65). Anthropological research indicates human hunter-gatherers tend to respond in such manners (e.g., Belovsky 1987, 1988; Bettinger 1991; Colson 1979; Earle 1980; Keene 1985; Hayden 1981; O'Connell and Hawkes 1981; Simms 1987; Winterhalder 1986). Thus, small mammal resources should be most abundant relative to large mammal resources during the mid-Holocene when the latter were supposedly depleted. Secondly, the diversity of mammalian resources should be highest during the mid-Holocene as all resources were exploited with more or less equal intensity rather than a selected few.

The effect of increased intensity of human occupation on hypotheses (1), (2), and (3) is for those hypotheses to have reverse implications; that is, frequencies of animal remains and taxonomic richness should increase as people shift adaptive strategies in response to increased aridity despite the fact that naturally available mammalian biomass may be decreasing in abundance. As dietary breadth increases, number of taxa (richness):NISP ratios should increase (e.g., from 1:10 to 2:10). If there are also indications that fewer sites were occupied during the mid-Holocene, and that those sites that were occupied were more intensively occupied during the mid-Holocene than before or after that time, then, given the argument presented here, these kinds of changes in these ratios can be taken as evidence for a decrease in naturally available biomass. However, if sites were occupied with a lower level of intensity during the mid-Holocene than before or after that time, the ratios described above may be similar between time periods if animal biomass was relatively high during the early and late Holocene and low during the mid-Holocene. That is so because lower occupational intensity suggests a lower level of competition than does high occupational intensity.

Faunal turnover should be indicated by discontinuous or incomplete temporal representation of taxa through the Holocene. However, if sample size, measured as the number of sites producing remains of a taxon or measured as the NISP per taxon, is influencing the apparent temporal range over which a taxon is found, then I expect to find statistically significant positive correlations between such variable pairs as taxonomic richness per temporal increment and NISP per

temporal increment, NISP per taxon per temporal increment and number of temporal increments in which a taxon is found, and number of sites producing remains of a taxon and number of temporal increments in which a taxon is found. Significant negative correlations between the number of gaps in the temporal distribution of a taxon and NISP per taxon are also expected if the available faunal data tend to monitor sample size rather than faunal turnover.

*Faunal responses to drought.*—Van Vuren (1987: see also Van Vuren 1984; Van Vuren and Bray 1983, 1985, 1986) suggests that the amount and distribution of herbaceous vegetation were the most significant factors controlling the abundance of bison during the Holocene of eastern Washington. Decreases in abundance of herbaceous vegetation, increased space between patches of herbaceous vegetation, or both, would result in a decrease in the population of bison and perhaps their local extirpation. McCorquodale et al. (1986) report that wapiti typically do not occupy arid areas void of extensive thermal cover (typically forest) due to the high cost of thermoregulation. They indicate, however, that wapiti can occupy big sagebrush *(Artemisia tridentata)* steppe habitats where adequate forage is available and they are not frequently disturbed. Increased hunting pressure brought on by decreases in other large mammals might, then, prompt wapiti to abandon the sage-steppe vegetation zone. The size and distribution of populations of bighorn sheep in southeastern Washington and southern British Columbia today seem closely related to forage quality (Estes 1979; Pitt and Wikeem 1978). Drought-induced reduction in forage quantity and quality has been shown to correlate with higher than normal lamb mortality (Johnson 1983), and thus populations probably would decrease significantly if arid conditions were to persist over many years. Pronghorn do not require free-standing water when forbs are abundant and have high moisture content, but during dry periods water consumption by pronghorn is high (Beale and Smith 1970). When drought reduces the quality of forage, pronghorn populations decline (Kitchen and O'Gara 1982).

Deer are polytypic in eastern Washington (both *Odocoileus hemionus* and *O. virginianus* are present), and while probably reduced in abundance during prolonged periods of aridity, this taxon would perhaps not have completely disappeared from that region during the mid-Holocene. Large carnivores such as bears *(Ursus* spp.) and cougars *(Felis concolor)* are so rare in archaeological assemblages from eastern Washington that it is difficult to determine if their absence is due to environmental conditions or to the fact that they were rarely taken by prehistoric hunters (e.g., Lyman 1986b). When their remains are recovered from archaeological contexts, they may thus be rather unreliable indicators of faunal change. At least some small mammalian taxa, such as the pygmy rabbit *(Brachylagus idahoensis),* seem to have increased in abundance and range during the mid-Holocene, while other small taxa, such as the pocket gopher *(Thomomys talpoides)* seem to have decreased in abundance at that time (Lyman 1991a).

Finally, if mammalian herbivores decreased in abundance during the mid-Holocene Altithermal climatic interval, it seems likely that the frequency of non-human mammalian carnivores would have similarly decreased. That is so because of lowered food supplies for the latter taxa, some of which feed not only on prey they have hunted and killed, but also on carrion. However, because mammalian

carnivores tend to occur high in trophic levels, they are naturally rare, and interpretations of prehistoric changes in their abundance must be viewed with caution.

## RESULTS AND DISCUSSION

*Lower Snake River.*—Intensity of occupation of sites in the Lower Snake River area is difficult to assess because the volume excavated per stratigraphic unit has seldom been reported. Interestingly, the single site that spans the entire Holocene (Marmes Rockshelter) produced a series of radiocarbon dates that has been interpreted by Sheppard et al. (1987) as indicating minimal occupation of that site between 6700 and 1900 B.P. I compiled all radiocarbon dates from sites in the Lower Snake River area known to me. Ten of the eleven sites producing faunal data have associated radiocarbon dates (45GA61 does not), and four additional sites not contributing faunal data to my analysis but found in this area have associated radiocarbon dates (45FR39, 45FR47, 45WT36, 45WW61). The frequency distribution of the 76 total dates, by 2000 year period, is shown in Fig. 2. Dates on charcoal are distinguished from those on freshwater mussel shell due to the debate concerning the validity of the latter (Chatters 1986; Sheppard et al. 1987). In this paper I presume shell dates are valid. Frequencies of dates per 2000 year period suggest stability of human occupational intensity until the last 2000 years, after which the intensity of occupation increased markedly.

Frequencies of dated sites per 2000 year period suggest slightly lower occupational intensity between 10,000 and 8000 B.P. and between 6000 and 4000 B.P. relative to the 10,000 to 8000 B.P. and 4000 to 2000 B.P. periods (Fig. 2). I suspect this results from the small sample of radiometrically dated sites for the early Holocene as there are three undated assemblages of artifacts temporally diagnostic of the early Holocene in this area (Brauner et al. 1990; Rice 1972). Thus there is no strong indication in the archaeological record for the Lower Snake River area of fluctuation in occupational intensity until the latest Holocene. Evidence of mid-Holocene change in occupational intensity may eventually be found in the Lower Snake as Chatters (1982) and Galm et al. (1981) present evidence indicating that the mid-Holocene absence of reliable water sources in the central, most arid part of the Columbia Basin resulted in human abandonment of that area during the Altithermal, and they suggest people moved to the canyons of major rivers at this time.

The total NISP per taxon correlates with both the number of temporal increments in which a taxon is found ($r_S = 0.66$, $p = 0.0005$) and with the number of sites producing remains of a taxon ($r_S = 0.76$, $p = 0.0001$), suggesting any apparent faunal turnover is probably a function of sample size (Table 3). The number of breaks in temporal continuity is correlated inversely with the total NISP per taxon ($r_S = -0.42$, $p = 0.02$) but perhaps not significantly with the number of sites producing remains of a taxon ($r_S = -0.30$, $p = 0.09$). These latter two coefficients also suggest caution is warranted before concluding faunal turnover took place. For example, taxa such as the western harvest mouse *(Reithrodontomys megalotis)* and the western jumping mouse *(Zapus princeps)*, both of which occur only during the latest Holocene, and pygmy rabbits, wolves *(Canis latrans)*, river

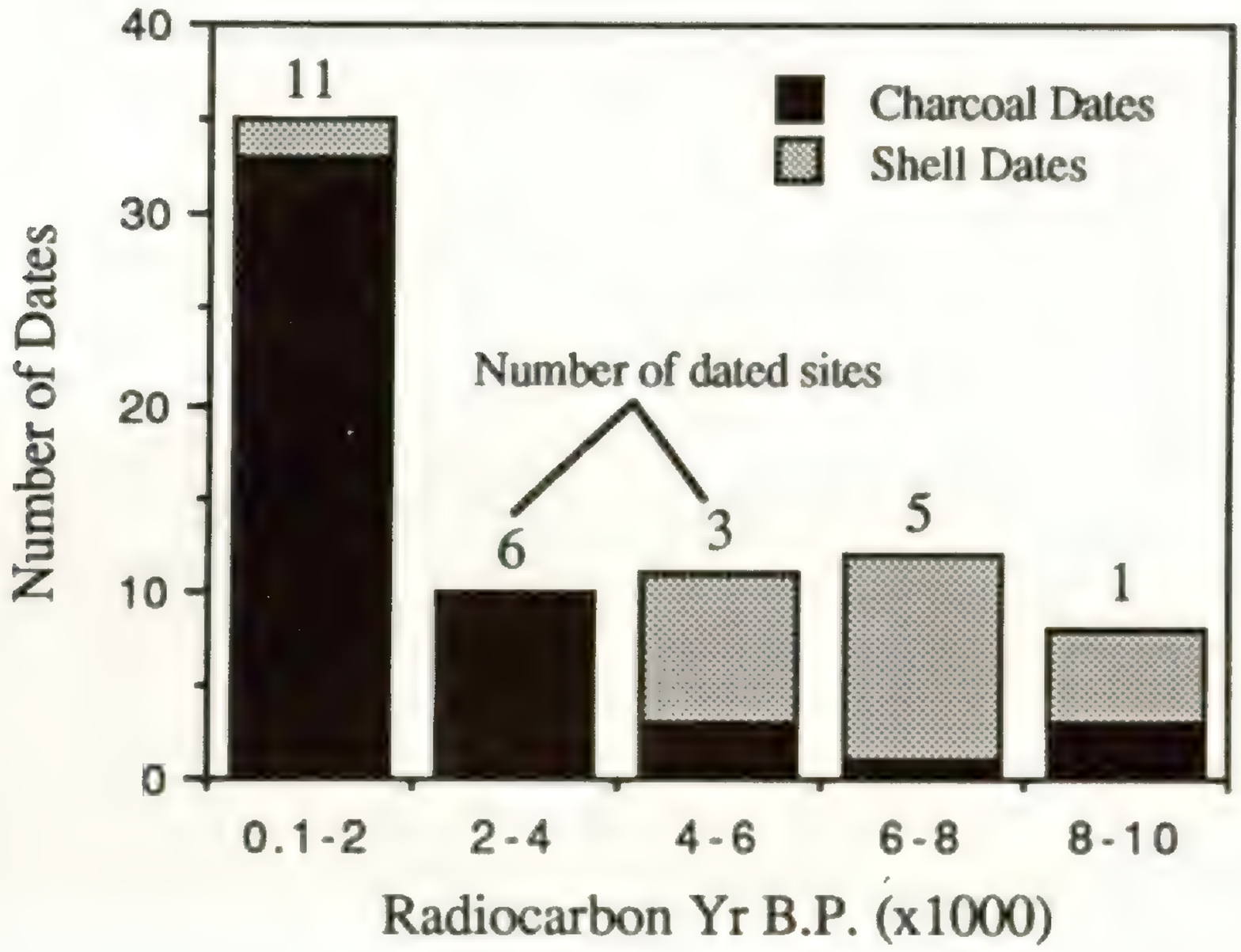


FIG. 2.—Frequencies of radiocarbon dates and dated sites in the Lower Snake River area.

otters *(Lutra canadensis),* and raccoons *(Procyon lotor),* which are reported only for the last 4000 years may not be represented in earlier time periods because 87.2% of the total Holocene NISP dates to the last 4000 years.

Further evidence that sample size is creating indications of faunal turnover is found in the fact that adding the data in Table 4 to that in Table 3 results in the omission of mid-Holocene gaps in the occurrence of beaver *(Castor canadensis),* vole *(Microtus* sp.), Great Basin pocket mouse *(Perognathus parvus),* deer mouse *(Peromyscus maniculatus),* bobcat/lynx *(Lynx* sp.), marten *(Martes americana),* badger *(Taxidea taxus),* and bighorn sheep. Other data indicate the red fox *(Vulpes vulpes)* also was present in eastern Washington throughout the Holocene (Lyman 1991b). While summing the two areal samples significantly increases the geographic area represented, it indicates Holocene faunal turnover in eastern Washington was probably minimal. Thus, instances of faunal turnover might be found in Table 3, but those are masked by the number of faunal specimens identified (NISP) and the number of sites sampled. The only clear evidence that faunal turnover took place involves the arctic fox *(Alopex lagopus),* which is recorded only for the early Holocene even though only 3.1% of the total Holocene NISP for the Lower Snake River area falls in that time period.

Taxonomic richness per temporal period ranges from a high of 30 between 2000 and 100 B.P. to a low of 15 between 6000 and 4000 B.P. (Table 3). In fact, taxonomic richness decreases steadily across the three temporal periods spanning the early and mid-Holocene, increasing only after 4000 B.P. This temporal synchrony with first increased aridity and then with decreased aridity conforms with hypothesis (4). Richness is lowest between 8000 and 4000 B.P., coincident with the Altithermal period, precisely when hypothesis (3) suggests richness

should be lowest. Before those hypotheses are accepted, however, sample-size effects must be considered.

TABLE 3.—Mammalian fauna for Lower Snake River. Values are number of identified specimens (NISP).

| | Years B.P. | | | | | | |
|---|---|---|---|---|---|---|---|
| Taxon | 10,000–8000 | 8000–6000 | 6000–4000 | 4000–2000 | 2000–100 | NISP | N of Sites |
| SMALL MAMMALS NOT USED AS FOOD | | | | | | | |
| *Spermophilus washingtoni* (Washington ground squirrel) | | 17 | 15 | 94.5 | 132.5 | 259 | 8 |
| *Spermophilus columbianus* (Columbian ground squirrel) | | 72 | 4 | 86 | 10 | 172 | 2 |
| *Thomomys talpoides* (northern pocket gopher) | 68 | 55 | 32 | 216 | 177 | 548 | 9 |
| *Perognathus parvus* (Great Basin pocket mouse) | 38 | | | 1.5 | 190.5 | 230 | 5 |
| *Reithrodontomys megalotis* (Western harvest mouse) | | | | | 165 | 165 | 1 |
| *Peromyscus maniculatus* (deer mouse) | 35 | 2 | | 1 | 5 | 43 | 4 |
| *Neotoma cinerea* (bushy-tailed woodrat) | 23 | 3 | 4 | 2.5 | 13.5 | 46 | 4 |
| *Microtus* spp. (vole) | 14 | 2 | | 12 | 17 | 45 | 9 |
| *Lagurus curtatus* (sagebrush vole) | 4 | 4 | 3 | 15.5 | 13.5 | 40 | 5 |
| *Zapus princeps* (western jumping mouse) | | | | | 2 | 2 | 1 |
| CARNIVORES | | | | | | | |
| *Canis* cf. *latrans* (coyote) | 5 | 36 | 5 | 37.5 | 85.5 | 169 | 10 |
| *Canus lupus* (gray wolf) | | | | 1 | 2 | 3 | 2 |
| *Alopex lagopus* (arctic fox) | 6 | | | | | 6 | 1 |
| *Vulpes vulpes* (red fox) | 5 | | | 0.5 | 0.5 | 6 | 2 |
| *Ursus americanus* (black bear) | | | | | 1 | 1 | 1 |

| Taxon | Years B.P. 10,000–8000 | 8000–6000 | 6000–4000 | 4000–2000 | 2000–100 | NISP | N of Sites |
|---|---|---|---|---|---|---|---|
| *Procyon lotor* (raccoon) | | | | 1 | 1 | 2 | 2 |
| *Martes americana* (marten) | 3 | | | | | 3 | 1 |
| *Mustela frenata* (long-tailed weasel) | 4 | | | | 3 | 7 | 3 |
| *Taxidea taxus* (badger) | | 1 | | 3 | 12 | 16 | 4 |
| *Lutra canadensis* (river otter) | | | | 1.5 | 1.5 | 3 | 3 |
| *Lynx* sp. (bobcat/lynx) | 1 | 1 | | 5.5 | 5.5 | 13 | 6 |
| MAMMALS USED AS FOOD | | | | | | | |
| *Brachylagus idahoensis* (pygmy cottontail) | | | | 1 | 47 | 48 | 2 |
| *Sylvilagus nuttallii* (Nuttall's cottontail) | 2 | 23 | 13 | 34 | 258 | 330 | 8 |
| *Lepus* sp. (jackrabbit) | 12 | 36 | 5 | 5 | 2,808 | 2,866 | 7 |
| *Marmota* cf. *flaviventris* (yellow-bellied marmot) | 14 | 10 | 1 | 3.5 | 3.5 | 32 | 4 |
| *Castor canadensis* (beaver) | 2 | | 1 | 22.5 | 3.5 | 29 | 6 |
| *Ondatra zibethicus* (muskrat) | 2 | 4 | 2 | 2 | 7 | 17 | 3 |
| *Cervus elaphus* (wapiti) | 6 | 99 | 8 | 47.5 | 479.5 | 640 | 11 |
| *Odocoileus* spp. (deer) | 29 | 226 | 57 | 284.5 | 937.5 | 1,534 | 11 |
| *Antilocapra americana* (pronghorn antelope) | 16 | 84 | 65.5 | 112.5 | 1,247 | 1,525 | 10 |
| *Bison bison* (bison) | | | 0.5 | 367.5 | 28 | 396 | 7 |
| *Ovis canadensis* (mountain sheep) | | 4 | | 5.5 | 39.5 | 49 | 6 |
| NISP | 289 | 679 | 216 | 1,364.5 | 6,696.5 | 9,245 | |
| N of Sites | 1 | 4 | 3 | 7 | 8 | | |
| Richness | 20 | 18 | 15 | 26 | 30 | | |
| Diversity | 2.469 | 2.167 | 1.962 | 2.158 | 1.873 | | |

TABLE 4.—Mammalian fauna for Upper–Middle Columbia River. Values are number of identified specimens (NISP).

| Taxon | Years B.P. 7000–4000 | 4000–2000 | 2000–100 | NISP | N of Sites |
|---|---|---|---|---|---|
| SMALL MAMMALS NOT USED AS FOOD | | | | | |
| *Sorex* sp. (shrew) | | 4 | | 4 | 3 |
| Aplodontidae (mountain beaver) | | 2 | | 2 | 1 |
| *Eutamias* sp. (chipmunk) | | 1 | | 1 | 1 |
| *Spermophilus* sp. (ground squirrel) | 12 | 85 | 22 | 119 | 13 |
| *Glaucomys* sp. (flying squirrel) | | 1 | | 1 | 1 |
| *Thomomys talpoides* (northern pocket gopher) | 1,201 | 1,576 | 253 | 3,031 | 24 |
| *Perognathus parvus* (Great Basin pocket mouse) | 341 | 429 | 198 | 968 | 20 |
| *Reithrodontomys megalotis* (western harvest mouse) | | 1 | 1 | 2 | 1 |
| *Peromyscus maniculatus* (deer mouse) | 22 | 87 | 25 | 134 | 17 |
| *Neotoma cinerea* (bushy-tailed woodrat) | 3 | 9 | 8 | 20 | 7 |
| *Microtus* spp. (vole) | 23 | 82 | 35 | 140 | 18 |
| *Lagurus curtatus* (sagebrush vole) | 21 | 73 | 65 | 159 | 15 |
| CARNIVORES | | | | | |
| *Canis* cf. *latrans* (coyote) | 44 | 131 | 45 | 220 | 18 |
| *Canis lupus* (gray wolf) | 3 | 5 | 1 | 9 | 4 |
| *Vulpes vulpes* (red fox) | | 7 | | 7 | 3 |
| *Ursus americanus* (black bear) | 8 | 9 | 4 | 21 | 5 |
| *Ursus arctos* (grizzly bear) | | 1 | | 1 | 1 |

| Taxon | Years B.P. 7000–4000 | 4000–2000 | 2000–100 | NISP | N of Sites |
|---|---|---|---|---|---|
| *Procyon lotor* (raccoon) | | 1 | | 1 | 1 |
| *Martes americana* (marten) | 2 | 6 | | 8 | 3 |
| *Martes pennanti* (fisher) | | 3 | 4 | 7 | 1 |
| *Mustela frenata* (long-tailed weasel) | | 4 | 4 | 8 | 4 |
| *Taxidea taxus* (badger) | 55 | 4 | 5 | 64 | 7 |
| *Mephitis mephitis* (striped skunk) | 8 | 2 | | 10 | 2 |
| *Lutra canadensis* (river otter) | | | 7 | 7 | 2 |
| *Felis concolor* (cougar) | | 4 | | 4 | 1 |
| *Lynx* cf. *rufus* (bobcat) | 5 | 3 | 1 | 9 | 2 |
| MAMMALS USED AS FOOD | | | | | |
| *Sylvilagus* cf. *nuttallii* (Nuttall's cottontail) | 11 | 5 | 17 | 33 | 9 |
| *Lepus* sp. (jackrabbit) | 16 | 30 | 9 | 55 | 13 |
| *Marmota* cf. *flaviventris* (yellow-bellied marmot) | 397 | 315 | 194 | 906 | 24 |
| *Castor canadensis* (beaver) | 10 | 44 | 15 | 69 | 12 |
| *Ondatra zibethicus* (muskrat) | 17 | 4 | 2 | 23 | 4 |
| *Erethizon dorsatum* (porcupine) | 68 | 8 | 1 | 77 | 4 |
| *Cervus elaphus* (wapiti) | 47 | 102 | 95 | 244 | 17 |
| *Odocoileus* spp. (deer) | 1,837 | 4,692 | 3,838 | 10,367 | 26 |
| *Antilocapra americana* (pronghorn antelope) | 95 | 146 | 490 | 731 | 17 |

TABLE 4.—Mammalian fauna for Upper-Middle Columbia River. Values are number of identified specimens (NISP). (continued)

| Taxon | Years B.P. 7000–4000 | 4000–2000 | 2000–100 | NISP | N of Sites |
|---|---|---|---|---|---|
| *Bison bison* (bison) | 11 | 26 | 2 | 39 | 5 |
| *Ovis canadensis* (mountain sheep) | 411 | 1,103 | 560 | 2,074 | 24 |
| NISP | 4,669 | 9,005 | 5,901 | 19,575 | |
| N of Sites | 13 | 21 | 10 | | |
| Richness | 25 | 36 | 27 | | |
| Diversity | 1.868 | 1.643 | 1.138 | | |

Both taxonomic richness per temporal period and the number of sites producing faunal remains per temporal period in the Lower Snake River area are correlated with the total NISP per temporal period (for both, $r_S = 0.90$, $p = 0.07$). These coefficients suggest richness may be a function of sample size and thus cannot be used in any straightforward manner to infer natural faunal change or change in human subsistence. As suggested earlier, if richness was lower during the mid-Holocene, human foragers may broaden their niche and take additional animal resources, a more diverse array of mammalian resources, more smaller mammalian resources, or some combination of these. Shannon diversity index values for the total mammalian fauna per temporal period for the Lower Snake and Upper-Middle Columbia faunas (Tables 3 and 4), when considered together, correlate with sample size ($r_S = -0.738$; $p = 0.05$), indicating mid-Holocene diversities appear to be more even than early or late Holocene diversities simply because the mid-Holocene assemblages are small. Diversity of mammalian faunas, then, provides no trustworthy evidence for changes in mammalian faunas or human subsistence strategies.

Prehistoric hunters probably did not, however, take all of the taxa listed in Tables 3 and 4, but it is difficult to determine from the published record precisely which taxa were regularly taken and which specimens listed in the tables were accumulated and deposited by human hunters. It seems likely that many specimens of the fossorial taxa such as gophers and ground squirrels (*Spermophilus* sp.) were naturally deposited, and perhaps some of the carnivore remains represent individuals that died of natural causes on the sites. Marmots (*Marmota flaviventris*), hares (*Lepus* sp.), rabbits (*Brachylagus idahoensis* and *Sylvilagus nuttallii*), beavers, and muskrats (*Ondatra zibethicus*) were clearly exploited by prehistoric peoples in eastern Washington, as were ungulates, based on archaeological evidence such as butchering marks. Considering only those non-carnivorous taxa which I believe were exploited by people (see Table 3), relative abundances of

the small taxa, from earliest to latest temporal period, are: 11.1%, 10.8%, 10.2%, 5.1%, and 46.7%. These proportions do not correlate with the NISP per temporal period ($r_S = 0.3$; $p > 0.2$) or with the number of sites producing faunal remains per temporal period ($r_S = 0.1$, $p > 0.2$), suggesting they are not a function of sample size. These relative abundances thus provide circumstantial evidence that prehistoric peoples did not shift to taking more smaller mammals during the mid-Holocene, but in fact decreased the frequency with which they were taken until the last 2000 years when, apparently, increased human populations (as indicated by measures of occupational intensity) resulted in increased competition and such small mammals became very important in the subsistence quest.

The NISP of carnivore remains per temporal period is correlated with both the total NISP per time period ($r_S = 1.0$, $p = 0.05$) and the number of sites producing mammal remains per time period ($r_S = 0.90$, $p = 0.10$), suggesting frequencies of carnivore remains are a function of sample size. (Note that in all cases the arctic fox is not included.) The diversity of carnivore taxa per time period is not correlated with the carnivore NISP per time period ($r_S = 0.20$, $p > 0.20$). Carnivore diversity is highest during the 10,000 to 8000 B.P. period (diversity = 1.507), and lowest from 8000 to 6000 B.P. (diversity = 0.241). It then increases between 6000 and 4000 B.P. (diversity = 0.688), and is higher still in the late Holocene (4000 to 2000 B.P. diversity = 0.987; 2000 to 100 B.P. diversity = 1.099). Carnivore richness per period is not correlated with carnivore NISP per period or the number of sites producing mammal remains per period ($r_S = 0.825$, $p > 0.1$ for both). The carnivore remains make up, from earliest to latest temporal period, 6.2%, 5.6%, 3.0%, 3.7%, and 1.8% of the total mammal remains. I suspect that these statistics are reflecting (a) relatively low carnivore biomass during the middle Holocene, and (b) decreased hunting of carnivores during the late Holocene, especially during the last 2000 years, as human foragers turned to other resources due to competition (see below).

Relative frequencies of ungulates increase through the Holocene (until 2000 B.P.) when only taxa utilized as food are considered; from earliest to latest these are: 88.9%, 89.2%, 89.8%, 94.9%, and 53.3%. This does not necessarily indicate that hypothesis (2) is wrong, but only that humans were not responding to hypothesized changes in the biomass of large mammals by taking such mammals in proportion to their hypothesized lower natural abundance. The drop in relative abundance of ungulates between 2000 and 100 B.P. corresponds to the increase in small mammal resources at that time. Again, this could well reflect the increased competition for resources that may have occurred as a result of increased intensity of human occupation at this time (refer to Fig. 2).

Ungulate NISP per temporal increment is correlated with total NISP of all mammals per temporal increment ($r_S = 0.90$, $p = 0.07$), suggesting ungulate NISP may be a function of sample size. From earliest to latest temporal period, ungulate remains make up 17.6%, 60.8%, 60.6%, 59.9%, and 40.8% of the total mammalian NISP. These proportions are precisely the *opposite* of that indicated in hypothesis (2); they do not correlate with total NISP ($r_S = 0.2$; $p > 0.2$) and thus do not seem to be a function of sample size. Apparently Gustafson (1972) was correct in noting that relatively more ungulate remains were deposited during the mid-Holocene than prior or subsequent to that time, but contrary to his belief those higher

frequencies do not appear to be attributable to increased human occupational intensity. I can offer no empirically warranted explanation for the changing frequencies of ungulate remains relative to the total mammalian fauna, but wonder if they might be attributable to a shift in human subsistence practices resulting in small mammals being gradually replaced by plants and fish during the mid-Holocene, which would result in fewer small mammal remains being deposited, especially during the mid-Holocene. There are, however, too few botanical and fish data to assess this possibility directly. Archaeological evidence indicates there was an increase in the relative abundance of plant processing and fishing tools during the mid-Holocene (e.g., Bense 1972; Galm et al. 1981) which could be taken as circumstantial evidence for low availability of mammalian biomass, especially small taxa (and carnivores?), during the mid-Holocene. After 4000 B.P., people continued to increase their exploitation of plants and fish, largely omitting small mammals and focusing more on large mammals, particularly ungulates.

Shannon diversity index values for only those mammals clearly exploited as food resources are, from earliest to latest: 1.725, 1.478, 1.349, 1.471, and 1.362. These do not correlate with NISP per temporal period ($r_S$ = -0.4, $p>0.2$), and thus seem to indicate decreasing diversity and increasing specialization on mammals between 10,000 and 4000 B.P., with only slightly more diversity between 4000 and 2000 B.P. after which diversity decreases again, perhaps, as suggested, due to increasing utilization of fish and plant resources.

*Upper-Middle Columbia River.*—Miss (1985:274) suggests that rates of accumulation of bone and lithic artifacts (measured as density of each per 1000 year temporal period) are "consistent after 4000 yr B.P." in the aggregated Chief Joseph Dam Reservoir sites. Prior to that time accumulation of artifacts was slower. If those accumulation rates are indicative of occupational intensity, then such intensity was lower prior to 4000 B.P. than after that time. Similar analyses of the Wells Reservoir materials cannot be performed, but the total radiocarbon dates for the Upper-Middle Columbia River area seem to conform to Miss's (1985) interpretation. As with the lower Snake River radiocarbon record, I compiled all radiocarbon dates for sites in the Upper–Middle Columbia River area known to me regardless of whether or not those dates were from sites producing faunal remains for this study. That resulted in 229 dates from 53 sites; 25 of the 28 sites contributing faunal data to my analysis have radiocarbon dates. As shown in Fig. 3, the frequency of radiocarbon dates is lowest between 7000 and 4000 B.P., but those frequencies are essentially equal for the 4000 to 2000 B.P. and 2000 to 100 B.P. time periods. As well, the frequencies of dated sites per temporal period suggest fewer sites were occupied prior to 4000 B.P. than after that time, and that the number of occupied sites was essentially the same for the latest two temporal periods. Thus I take occupational intensity to have been somewhat lower between 7000 and 4000 B.P. than subsequent to 4000 B.P.

The total NISP for this area is larger than that for the Lower Snake River area, but the Upper-Middle Columbia River faunal record spans only the last 70% of the Holocene. Presuming this means that the Upper-Middle Columbia River sample is more representative of the mid- and late Holocene than the Lower Snake

River sample is, there should be less evidence of sample-size effects in this set of assemblages. NISP per taxon is, however, correlated with the number of sites producing remains of a taxon ($r_S = 0.97$, $p<0.0001$) and with the number of temporal periods in which a taxon is represented ($r_S = 0.85$, $p<0.0001$). Similarly, the number of sites producing remains of a taxon is correlated with the number of temporal periods in which a taxon is found ($r_S = 0.81$, $p<0.0001$). These correlations suggest the appearance of faunal turnover in Table 4 may be the result of sample size. The single possible exception is the occurrence of river otter between 2000 and 100 B.P. because only 30% of the total NISP dates to that time period and the 4000 to 2000 B.P. sample is almost 53% larger than the 2000 to 100 B.P. sample.

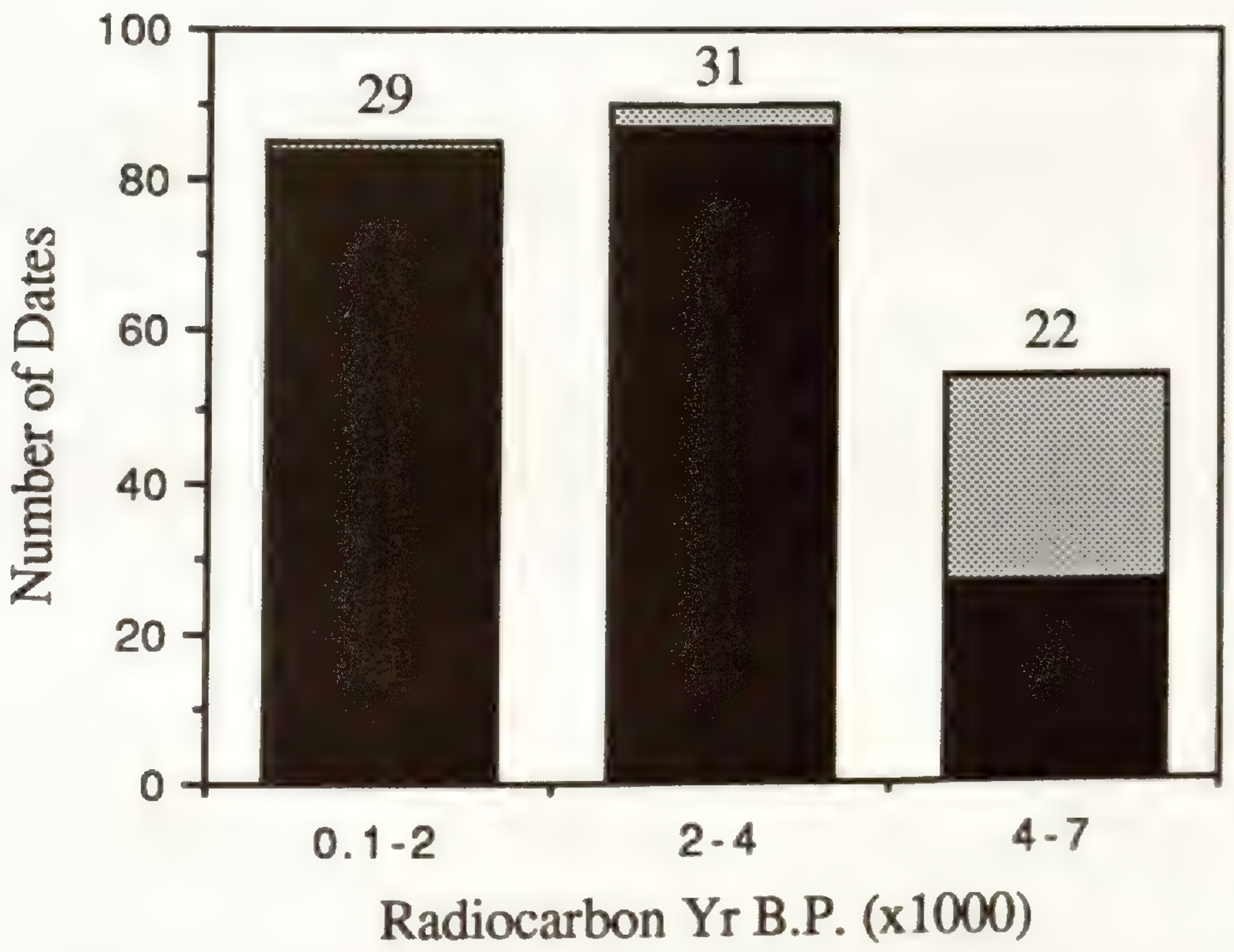


FIG. 3.—Frequencies of radiocarbon dates and dated sites in the Upper-Middle Columbia River area. See legend for Figure 2.

Three taxa represented in the two latest samples are not represented in the 7000 to 4000 B.P. sample: western harvest mouse, fisher *(Martes pennanti),* and long-tailed weasel *(Mustela frenata)*. As well, two taxa represented in the earliest samples are not represented between 4000 and 100 B.P.: striped skunk *(Mephitis mephitis)* and marten. Five of the six taxa (including river otters) mentioned thus far are mustelids, and it is perhaps significant, then, that one of the Wells Reservoir sites not included in my analysis or in Table 4 due to small sample size (NISP <30) produced a single specimen of wolverine *(Gulo luscus)* dating between 7000 and 4000 B.P. (Chatters 1986). The significance of this is probably not that six of these seven taxa are mustelids, but rather that they are carnivores, taxa which are typically rare in eastern Washington archaeological sites. For example, four of the eight taxa represented only in the 4000 to 2000 B.P. assemblage are carnivores: cougar *(Felis concolor)*, raccoon, grizzly bear *(Ursus arctos),* and red fox. That

is, of the 14 taxa not continuously represented between 7000 and 100 B.P., nine (64%) are carnivores (10 of 15, or 67%, if the wolverine is included). Thus if faunal turnover took place along the Upper-Middle Columbia River during the last 7000 years, I do not believe it is clearly reflected in Table 4. What appears to be faunal turnover in this table is more likely a reflection of sample size effects.

Carnivore NISP per temporal period does not reflect the total NISP per temporal period (I did not calculate correlation coefficients because there are only three cases), but carnivore NISP per period does reflect the number of sites sampled per period. Neither carnivore richness per period nor carnivore diversity per period mirrors carnivore NISP per period. Carnivore diversity is greatest between 7000 and 4000 B.P. (diversity = 1.366), and progressively decreases through time (diversity between 4000 and 2000 B.P. = 1.223; diversity between 2000 and 100 B.P. = 1.101). As in the Lower Snake River area samples, carnivores decrease in abundance from the middle Holocene (7000 to 4000 B.P.) when they account for 2.7% of all mammalian remains, to 2.0% between 4000 and 2000 B.P. and 1.2% between 2000 and 100 B.P. Faunal turnover and changes in biomass are not apparent here, but the decreased abundance of carnivores may reflect changes in human subsistence (see below).

While I did not calculate correlation coefficients here because there are only three cases, it is important to note that taxonomic richness per temporal period is perfectly correlated with total NISP per temporal increment (Table 4). This suggests richness per temporal period may be an effect of sample size. Recall that optimal foraging theory suggests dietary breadth (richness and/or diversity) will increase as resources become scarce or as competition for resources increases. Thus, during the mid-Holocene along the Upper-Middle Columbia, if resources were scarce but occupational intensity was relatively low, dietary breadth at that time may have been similar to dietary breadth during the late Holocene (last 4000 years) when resources were more abundant but occupational intensity was relatively high. But the diversity of mammalian food resources decreases from the mid-Holocene to the latest Holocene; Shannon diversity index values for only those taxa used as food (same taxa as for Lower Snake), from earliest to latest are: 1.084, 0.925, 0.935. That could be taken as evidence that mammalian biomass was low during the mid-Holocene, and people broadened their niche by taking a more diverse set of mammalian resources during this time, but those index values are perfectly inversely correlated with the NISP of taxa used as food per temporal period, indicating that the smaller the NISP the greater the diversity index value.

The proportions of mammals used as food that are small taxa are from earliest to latest 9.7%, 4.4%, and 4.0%. These relative frequencies do not correlate with the total NISP per temporal period, suggesting they are not a function of sample size. They indicate more small mammals were used as food between 7000 and 4000 B.P. than subsequently, and this might be taken as circumstantial evidence for a mid-Holocene decrease in naturally available mammalian biomass. These proportions do not seem to be a result of intensity of human occupation as occupational intensity was apparently low during the mid-Holocene. And, as with the Lower Snake River sample, when only mammalian taxa used as food are con-

sidered, the relative abundance of ungulates increases from earliest to latest suggesting that a more specialized economy focusing on ungulates emerged in the last 4000 years, at least in terms of mammalian resources.

It was suggested that in the Lower Snake River area, fish and plants became more important resources with the emergence of Altithermal climates and that these resources retained some importance after 4000 B.P. Of the 10,362 fish remains identified from sites in the Upper-Middle Columbia River area, 32% date between 7000 and 4000 B.P., 57.3% date between 4000 and 2000 B.P., and 10.7% date between 2000 and 100 B.P. (fish data compiled like mammalian data, but without regard for specific site sample sizes). Presuming fish were used as food by prehistoric human occupants of the area (fish were important ethnographically), from earliest to latest fish make up 28%, 47.9%, and 38.8% of the summed food mammal and fish remains. These proportions suggest fish were a more important food resource after 4000 B.P. than during the mid-Holocene, but their importance during the early Holocene in this area is unknown. Thus it seems small mammals decreased in importance while large mammals, especially ungulates, and fish increased in importance in the Upper-Middle Columbia River area after the mid-Holocene.

Absolute frequencies of ungulate remains per temporal period are perfectly correlated with the total mammalian NISP, but their relative frequencies in the complete faunas are, from earliest to latest, 51.4%, 67.4%, and 84.5%, and these do not correlate with the total mammalian NISP. These values align with hypothesis (2), that ungulate biomass was at its lowest during the mid-Holocene. Why these frequencies increase through time probably has to do with competition. The low occupational intensity and perhaps low mammalian biomass between 7000 and 4000 B.P resulted in ungulates representing only about half of the deposited mammalian remains. After 4000 B.P., human occupational intensity increased, competition increased, and ungulate biomass increased as well. The relative frequencies of ungulate remains suggest the latter may have out-paced the former two variables, permitting an increasingly specialized mammalian subsistence base consisting largely of ungulates.

## CONCLUSIONS

The possible responses of mammalian communities to changing Holocene climates and of human hunter-gatherers to fluctuating resource abundances led researchers working 30 years ago in eastern Washington to suggest that (a) mammalian biomass was at its lowest level during a mid-Holocene period of relative aridity and (b) that humans would respond by taking a broader range of resources. Those suggestions are easily phrased as hypotheses, but in order to be tested they must take into account the effects of sample size on measures of taxonomic richness, diversity, and turnover, and the effects of human occupational intensity on measures of animal abundances.

Frequencies of radiocarbon dates and of dated sites indicate human occupational intensity of the Lower Snake River area was relatively stable from 10,000 B.P. until about 2000 B.P. Faunal turnover during the Holocene there is largely

obscured by sample-size effects but minimally entailed loss of the arctic fox in the early Holocene. Mammalian biomass appears to have been at its lowest level between 6000 and 4000 B.P., having decreased steadily since the end of the Pleistocene, much as was suggested 30 years ago, but problems of sample size make such a conclusion tenuous. Human occupational intensity does not account for a perceived steady increase in the relative abundance of ungulate remains between 10,000 and 2000 B.P.; rather, that increase may be a function of decreased deposition of the remains of non-ungulate mammals, especially those small mammals such as leporids and marmots that were humanly exploited. Gradually and throughout the Holocene human foragers took fewer and fewer small mammals. Archaeological data indicate the gradually increasing focus on ungulates seems to have accompanied a shift in subsistence pursuits to increased reliance on plant and fish resources in the last 4000 years.

Rates of artifact deposition and frequencies of radiocarbon dates and dated sites indicate the Upper-Middle Columbia River area was less intensively occupied between 7000 and 4000 B.P. than after that time. Indications of faunal turnover there involve mostly carnivores, which are rare naturally and archaeologically, and thus seem to provide poor indications of change in the taxonomic composition of the mammalian community. Stability in abundances of faunal remains relative to site frequencies and taxonomic richness can be accounted for by a combination of low occupational intensity and low mammal biomass during the mid-Holocene, and by a combination of higher occupational intensity and higher mammalian biomass during the last 4000 years. As with the Lower Snake River fauna, human foragers living along the Upper-Middle Columbia River seem to have slowly shifted their mid-Holocene subsistence pursuits to taking more ungulates and fish in the late Holocene.

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## BOOK REVIEW

**The Mixe of Oaxaca. Religion, Ritual, and Healing.** Frank J. Lippo. Austin, Texas: University of Texas Press, 1991. Pp. xx, 253. $35.00 (clothbound). ISBN 0–292–76517–7.

The product of extensive field work spanning five trips (one of which lasted 16 months) and thorough bibliographic research, this book is indeed a welcome contribution to ethnobotany and anthropology of Oaxaca and particularly of one of the most poorly known native cultures of Mexico. It is not frequent that an Indian group of 76,000 individuals living in some 50 villages in a country where so much anthropological work has been carried on for so long has escaped such dedicated study as that apparent in this volume. As Dr. Munro Edmonson, anthropologist at Tulane University, states: ''Mixe culture and Lippo's description of it stands alone in the Middle American ethnography ... . This work fills a gap in the literature for which there is no alternative and no competition.''

A long introduction acquaints the reader to the methodology used in the field studies. Then follows nine chapters: Social Organization and Kinship; Subsistence Agriculture; Religious Belief System; Calendrical System; Ritual Behaviour; Rites of Passage; Village Festivals; Medical Concepts and Behaviour; Postscript. There are three appendices: Mixe Region; Mixe Phonemes; Mixe Texts. Fifteen pages are devoted to two lists of names: one of Mixe terms, the other Spanish and Nahuatl words. The bibliography of literature cited enumerates 306 items. There is a detailed index.

This masterly book is beautifully published and conservatively priced.

Richard Evans Schultes
Director Emeritus
Botanical Museum of Harvard University
Cambridge, Massachusetts

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# AN OPTIMAL FORAGING ANALYSIS OF PREHISTORIC SHELLFISH COLLECTING ON SAN CLEMENTE ISLAND, CALIFORNIA

L. MARK RAAB
*Department of Anthropology*
*California State University*
*Northridge, CA 91330*

ABSTRACT.—The subsistence yield of black abalones *(Haliotis cracherodii)* and black turban snails *(Tegula funebralis)* was estimated within prehistoric aboriginal shell middens dated 250–2830 B.P. on San Clemente Island, California. Abalones were the key element of the aboriginal shellfish economy, but consumption of the smaller turban snails increased with depletion of abalones in a pattern that conforms to an optimal foraging model of predation.

RESUMEN.—El rendimiento de abalón negro *(Haliotis cracherodii)* y caracol de turbante negro *(Tegula funebralis)* para la subsistencia de las poblaciones indígenas fue estimado en concheros prehistóricos (250 a 2830 años antes del presente, datados con carbono radioactivo) en la Isla de San Clemente, California. Los abalones fueron el elemento clave en la economía aborigen de mariscos, pero el consumo de los caracoles de turbante, más pequeños, aumentó con el agotamiento de los abalones en un patrón que concuerda con un modelo de depredación como forrajeo óptimo.

RESUME.—Des traces de présence d'haliotides noires *(Haliotis cracherodii)* et d'escargots noirs à turban *(Tegula funebralis)* ont été découvertes au sein de vestiges résiduels préhistoriques de coquillages aborigènes (250 à 2830 années radiocarbones avant le temps présent) sur l'île de San Clemente, en California. Les haliotides constituaient l'élément principal de l'économie de coquillages aborigènes, mais la consommation des escargots à turban, bien plûs petits, s'est acrue au fur et à mesure de la disparition des haliotides selon une progression conforme à un modèle optimal de ravages causés par des prédateurs.

Marine gastropod species were important subsistence resources among the aboriginal peoples of the southern California Channel Islands. Two species, the black abalone (*Haliotis cracherodii* Leach, 1814) and the black turban snail (*Tegula funebralis* A. Adams, 1855), are the focus of the present discussion. Abalone shells are a conspicuous component of prehistoric middens (domestic refuse deposits) on the Channel Islands. Beads, ornaments, fishhooks, containers, and other artifacts were manufactured from abalone shells. Despite this presence, reconstruction of the subsistence role of abalones and other shellfish species remains a relatively poorly developed area of investigation. Reconstructions usually estimate food yields based upon shell weight or MNI (minimum number of individuals) figures. Frequently, such estimates do not reflect the possibility that several species may have been utilized in shifting patterns of exploitation over

the time interval represented by a midden. This situation is surprising when one considers that the role of shellfishing by maritime hunter-gatherers is currently undergoing reexamination in many quarters. Recent archaeological and ethnographic studies have demonstrated the important role that shellfishing may play within a variety of economic adaptations. Consideration of biological characteristics of shellfish species, combined with appropriate analytical methods, reveal dynamic patterns of aboriginal shellfish collecting on San Clemente Island, southern California.[1]

## ABALONE AND TEGULA BIOLOGY

Abalones are large, herbivorous marine snails that inhabit many regions of the world. They require rock surfaces, where they attach themselves with a large, muscular "foot." Thus attached, they are protected by a thick univalve shell from predators and other hazards while grazing on floating kelp fragments. Species are readily differentiated based upon shell morphology. Water drawn through the gills is expelled through a series of prominent respiratory pores arrayed along the shell, the number and characteristics of which also vary by species (Howorth 1988:38–44). Abalone species occupy much of the Pacific Coast of North America, including California (Morris 1966:52), as well as Australia, New Zealand, and elsewhere.

Four species occur in significant frequencies within archaeological deposits of southern California. The three largest of these species generally occupy the subtidal zone; i.e., rocky substrates that remain submerged even during the lowest tides. Although these species vary in size and specific habitat requirements, they all inhabit substantially similar environments. Among the subtidal forms is the largest species in the world, the red abalone *(Haliotis rufescens)* with a shell length approaching 300 mm and a soft-tissue weight of as much as 3 lbs (1.36 kg; Morris et. al. 1980:232; Ault 1985:4). The green *(H. fulgens)* and pink *(H. corrugata)* abalones reach a maximum length of about 250 mm (Ault 1985:4; Morris et. al. 1980:234–235). All the subtidal species inhabit a depth gradient from the intertidal zone to at least 165 m for the red abalone, 18 m for the green abalone, and 50 m for the pink abalone. In cooler waters, such as found north of Point Conception in California, red abalone and other species may be found in the intertidal zone. The majority of individuals of subtidal species tend, however, to occur most frequently between about 6 m and 24 m (Cox 1960:386–390; Ault 1985:15–16). A number of factors appear to affect preferred depth, including algal production, habitat that offers protection to juvenile abalones, the presence of predators such as the sea otter, and water temperature (Ault 1985:15–16; Morris et al. 1980:232).

Generally, subtidal species can only be obtained by diving. Where these species exist in comparatively shallow water, diving can produce large harvests. The relatively large size of the subtidal forms may compensate for the effort involved in diving. It has also been suggested that red abalone may have been intertidal during the early and mid-Holocene (i.e., around 5000–7000 B.P.; Glassow et al. 1988:70), when periods of sea temperature cooler than at present may

have existed in the California Bight (southeastward bend of the California coast below Point Conception). A spatulate prying device (aboriginal forms were made of bone or wood) is generally required to break the animal's extremely powerful grip on its rocky perch.

Water temperature has a major impact on the life-cycle of subtidal abalones, with each species exhibiting a particular tolerance range. The red abalone, for example, feeds between 7° and 20°C, but the thermal optimum for the species is between 14° and 18°C (Ault 1985:15). Water temperature requirements are probably more important in relation to paleoenvironmental reconstruction than assessment of dietary yield. Use of abalone species as indicators of past marine environmental regimes is a topic important to archaeological research in southern California, but beyond the scope of this paper (Walker and Snethkamp 1984:7; Glassow 1977:19; Glassow et al. 1988:70; Raab and Yatsko 1990a, 1990b).

During abalone reproduction, eggs and sperm are released into the water, where fertilization occurs. After fertilization, larvae begin grazing within a few days. Initial growth of all species is relatively rapid, reaching about 20–30 mm within the first year (Morris et. al 1980:232–237; Ault 1985:5–6). After reaching the juvenile stage, abalone grow more slowly, adding a few millimeters length each year. Abalone appear to reach sexual maturity within 3–5 years, and it is thought that few individuals live longer than 20 years (Morris et al. 1980:232–237). All abalone species are slow growing organisms with few defenses against human predators. Consequently, their numbers are rapidly reduced under sustained collecting, and considerable time is required for a population to recover.

The black abalone *(Haliotis cracherodii)*, the species of interest in the present discussion, is largely an intertidal form. These organisms frequently are exposed during low tides on rocks, where they can exist in large numbers. These abalone may be particularly at risk from human predators because they are easily harvested without diving. Individuals of this species reach a maximum size of about 200 mm, but few individuals exceed 150 mm. Black abalone have temperature requirements similar to red abalone (Ault 1985:15). Black abalone, as in the case of other abalones, requires several years to reach maximum size; about 2 years to reach 55 mm, then growing about 4 mm a year after reaching 90 mm in length (Ricketts et al. 1985:245). During early phases of growth, abalones seek the protection of rock crevices to avoid predators. Individuals become *emergent* upon reaching a length of 75–100 mm; i.e., they venture onto exposed rock surfaces in search of food (Ault 1985:6).

The black turban snail *(Tegula funebralis)* is common to abundant on open rocky surfaces of the intertidal habitats that support the black abalone (Morris et al. 1980:253). The smooth, rounded to conical shell may reach a diameter of 30 mm, though many individuals are much smaller. At low tide *T. funebralis* is sedentary, and hundreds of individuals often aggregate in rock crevices. Locomotion is achieved with a muscular foot in the same fashion as other marine gastropods. Tegula are herbivores that eat many species of algae, including microscopic films and kelp fragments (Morris et al. 1980:253). They may reach 20–30 years of age, and thus may have a lifespan longer than any other gastropod (Morris et al. 1980:254). Like black abalone, black turban snails are readily exploited by terrestrial predators during low tide.

## RETHINKING THE LOWLY SHELLFISH

As compared to terrestrial resources, shellfish often have been characterized as ''emergency'' or low-yield foods of comparatively minor importance. Osborn (1977) argues, for example, that marine environments are generally less productive per unit area than terrestrial environments. He suggests that human populations tend to relegate marine resources to a lower order of importance if terrestrial resources are available. The open ocean is less productive than many terrestrial ecosystems (Pianka 1974:48), but Yesner (1980) and Erlandson (1988, 1991) point out that this fact is misleading in view of the comparatively high productivity of certain coastal habitats.

Shellfish collecting has long been regarded as unimpressive as a gauge of cultural ''advancement.'' Uhle (1907:31), for example, dismissed the prehistoric inhabitants of the Emoryville shell mounds in California as representative of the ''lower classes of society'' owing to their dependence on shellfish:

> The manner of procuring the essentials of life by collecting shells in itself indicates a low form of human existence. In all parts of the world, even today, people may be seen by the shore at low water collecting for food the shells uncovered by the retreating tide; and although under changed conditions of life they raise shellmounds, these people always belong to the lower classes of society, and lead in this manner a primitive as well as simple life.

Meehan (1982), in her excellent ethnographic study of shellfishing in Australia, points out the many misconceptions and biases that have worked against an informed understanding of shellfish economies. Fortunately, the significance of shellfish in maritime adaptations recently has received more objective attention. Sanger (1988:91), for instance, notes the important role of shellfish in settlement patterning and subsistence in the northeastern United States:

> Shellfishing, obviously an important aspect of the Gulf of Maine maritime adaptation, required only the use of hands to pluck mussels from rocks, or ''pick'' clams through their siphon holes... Briefly, shellfish, although frequently belittled in the literature as gross contributors to the overall caloric component of shell midden sites, may have constituted the primary motivation for site selection and abandonment. They constituted a reliable, if not spectacular, food source, and it would have been possible to over-exploit resources in the kinds of intertidal flats commonly found associated with habitation sites. A pattern of brief occupation, followed by movement to another site, may help to explain the presence of nearly 2,000 known shell midden sites an the coast of Maine that have survived erosion due to a submerging shoreline.

Erlandson (1988:107), in evaluating the role of shellfish in the prehistoric maritime economy of southern California, makes a similar point:

> ... I have tried to counter previous assertions that shellfish exploitation is universally inefficient subsistence strategy by demonstrating that, under

> a variety of conditions, shellfish can serve as an efficient and sustained protein yield. This hypothesis has been supported with experimental data on protein yields for shellfish collecting, an archaeological example from coastal California, and a reexamination of two previous models of shellfish exploitation.

Recent evidence suggests that coastal populations of early Holocene (7000–10,000 B.P.) southern California subsisted on a diet in which calories were supplied to a large extent by hard seeds, and substantial protein was provided by shellfish (Erlandson 1991).

Relying on both ethnographic and archaeological data, Davidson (1984) demonstrates the important role played by shellfishing in the aboriginal settlement-subsistence systems around Palliser Bay, New Zealand. Virtually in a class by itself, the study by Meehan (1982) of aboriginal shellfishing in Australia provides detailed data on the ecology, social organization, nutritional yield, and integration with larger economic systems of shellfish economics.

The result of these investigations is increasing recognition of the distinctive and important roles of shellfishing. This recognition should prompt archaeologists to go beyond the cursory treatment of shellfish remains that have been characteristic of many research efforts of the past:

> ... the economics of shellfish exploitation should be evaluated in relation to the productivity and reliability of other resource alternatives, including factors such as the nutritional role played by various resources, the technological investment in resource acquisition, non-food payoffs, the availability of various foods to different age and gender groups within a society, seasonal limitations on the availability of different resources, and differential storability (Erlandson 1989:15).

## SAN CLEMENTE ISLAND

San Clemente Island, 58 sq mi (148 sq km) in extent, is the southern-most of the eight Channel Islands found off the southern California coast (Fig. 1), and lies 48 mi from the nearest landfall on the mainland. In historical times the island was occupied by the island Gabrielino Indians (Johnson 1988; Bean and Smith 1978). Although the island's culture history is poorly understood at present, recent archaeological studies indicate a human occupation of nearly 10,000 years (Salls 1988:353–362). The island contains evidence of some of the oldest maritime cultural adaptations on the Pacific coast of North America (Raab and Yatsko 1990a, 1990b).

During the Miocene, the island was thrust above the ocean by block faulting. This process, combined with rising and lowering ocean levels during the Pleistocene, has formed at least 18 wave-cut terraces on the island's west shore (Olmsted 1958). Active terrace-cutting produces a broad, rocky shelf of the type that characterizes most of the island's west shore today. Rocky intertidal, shallow reef, and kelpbed habitats support a rich marine ecosystem characteristic of rocky substrates. A number of gastropod species, including abalones, inhabit this zone.

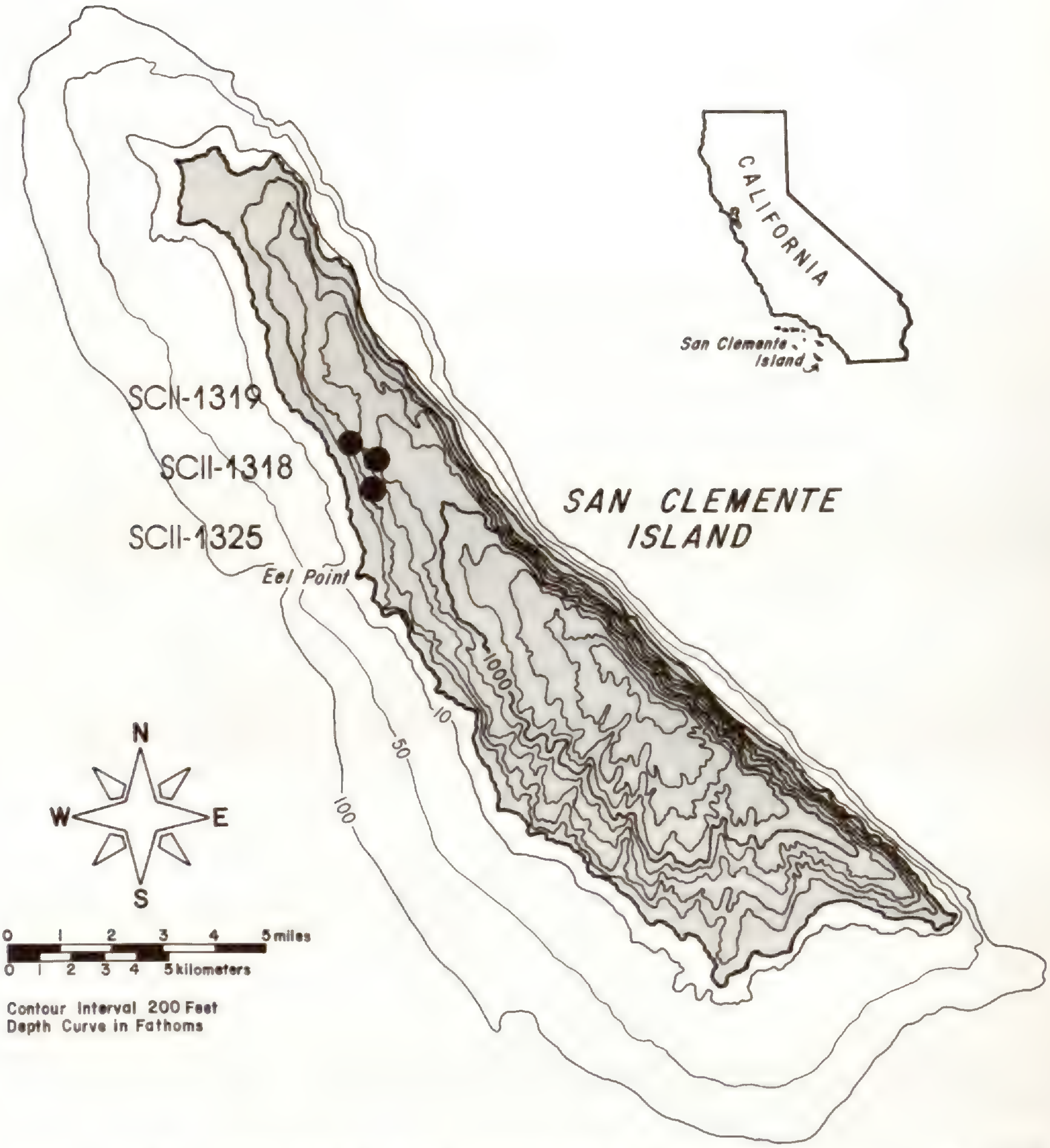


FIG. 1.—San Clemente Island, California. Archaeological sites SCII-1318, SCII-1319, SCII-1325, and the Eel Point site (SCII-43) are indicated.

Significantly, marine terraces have the greatest number of archaeological sites per sq km of any physiographic zone on the island; frequently 200–300 per sq km (Yatsko 1987a, 1987b). Most sites are relatively small, discrete shell midden sites, some of which have apparent house floor depressions. The site in Fig. 2 is characteristic of the small, shallow shell middens found on the coastal terraces of San Clemente Island. The Eel Point site complex (SCII-43), covering many acres and producing the oldest dated cultural component on the island (9700 B.P.; Salls 1988:353–369),is found within this zone.

Three coastal midden sites, SCII-1318, SCII-1319, and SCII-1325, were partially excavated. These sites are located on a high marine terrace, approximately 300 m above sea level, on the central west side of the island (Fig. 1). Sites SCII-1318

FIG. 2.—Midden sites on the west shore of San Clemente Island are characteristicly small, spatially discrete shell middens. The broken line indicates limits of midden (site SA-61; photo by Andrew Yatsko).

and SCII-1319 were selected for excavation because they appeared typical of hundreds of others in the area, and were comparatively easy to reach from an existing road. Both sites are black, ashy midden deposits containing abundant marine shell and burned rock deposits. All three sites were systematically tested with a soil auger, 10 cm in diameter, in order to estimate their subsurface character and extent. Based on the auger data, excavation units were placed to obtain samples of midden from the deepest to the shallowest portions of the deposits at a site.

Site SCII-1318 is approximately 24 m (north-south) by 16 m (east-west), with a total volume of approximately 41 $m^3$. Four 1 m by 1 m excavation units were placed within this site; one near the periphery, two in the deepest midden deposits, and one between the periphery and the two deep pits. All excavation units were dug to a depth of 30 cm below surface, for a total of 1.20 $m^3$ of excavated midden matrix.

Site SCII–1319 proved to be nearly circular in outline, 21 m in diameter, with a volume of approximately 76 $m^3$. Four 1 m by 1 m excavation units were excavated within the site; two near the center and deepest portion of the deposits, one at the periphery, and one between the center and periphery. Three excavation units were dug to a depth of 40 cm, and one unit reached a depth of 30 cm before encountering culturally sterile sediments, for a total of 1.5 $m^3$ of excavated midden matrix.

Site SCII–1325 was selected to salvage information from a midden damaged by past military activities. A military ''foxhole'' had been dug into the center of the midden, exposing a 60–cm–deep midden stratum. The depth of this site is unusual for coastal midden sites in this area. We examined this stratum in the area of the site damaged by the foxhole. A portion of the wall of the foxhole was cleaned and a vertical profile established. A 1 m by 1 m unit was excavated into the midden deposit from the cleaned profile. This site was approximately 30 m in diameter, with the excavation unit located near the center of the site. The site contains about 212 $m^3$ of midden. The excavation unit was dug to a depth of 60 cm, yielding a total volume of 0.6 $m^3$ of excavated midden matrix. Despite efforts to clear away midden deposits disturbed by the excavation of the foxhole, variability in compaction of the midden matrix and other factors suggest a reversed stratigraphic sequence.

Two of these sites have been radiocarbon dated. However, these dates present difficulties that cannot be resolved within the scope of this paper. Paired samples of charcoal and shell were taken from each excavation level of the two sites (''arbitrary'' 10–cm levels). Unfortunately, the dates of charcoal and shell samples from the same midden proveniences vary greatly; far beyond differences one might expect to result from the $^{14}C$ ''reservoir effect'' (Stuiver et al. 1986). In radiocarbon years before present these dates are:

Site SCII-1318:

| | Charcoal Dates | Shell Dates |
|---|---|---|
| 0–10 cm | 250+/–50 (Beta–39148) | 1560+/–60 (Beta–39143) |
| 10–20 cm | 350+/–50 (Beta–39146) | 1777+/–50 (Beta–39145) |

Site SCII-1319:

| | Charcoal Dates | Shell Dates |
|---|---|---|
| 10–20 cm | 240+/–50 (Beta–39148) | 2160+/–50 (Beta–39147) |
| 20–30 cm | 300+/–70 (Beta–39150) | 2830+/–50 (Beta–34149) |

No time-diagnostic artifacts were found in the middens. Studies are in progress by the author to identify possible sources of errors in radiocarbon dating on San Clemente Island, but at present one can only safely conclude that the sites are of late Holocene age.

As noted above, excavation units were dug in 10-cm levels to culturally sterile sediments. All excavated midden was passed through 1/8'' (5 mm) mesh screen. Material collected in the screen was sent to the lab where *all* recovered midden constituents were identified and weighed. The resulting data were entered into a computer data base. The sheer volume of shell and other materials to be

identified and recorded imposed a substantial analytical burden. Nearly 480 person-hours were required to analyze and record the 3.3 $m^3$ of midden matrix recovered by our excavations.

Analysis identified a broad spectrum of subsistence remains. For purposes of analysis, however, emphasis was placed upon five classes of faunal remains which are useful indicators of a number of ecological and subsistence variables: abalone *(Haliotis)* shell, *Tegula* shell, sea urchin tests (hard body parts) and spines, sea mammal bone, and fish bone (Table 1). Most of the abalone shell from the middens was fragmentary. All specimens are black abalone *(H. cracherodii),* common to the island's rocky west shore. *Tegula funebralis,* the small black turban snail inhabiting the intertidal zone of the west shore (Hedgpeth and Hinton

TABLE 1.—Tabulation by weight (gm) of midden constituents, by stratigraphic levels, for sites SCII-1318, SCII-1319, and SCII-1325.

| | *Haliotis* | *Tegula* | Sea Urchin | Mammal Bone | Fish Bone | *Tegula/ Haliotis* Ratio |
|---|---|---|---|---|---|---|
| SCII-1318: | | | | | | |
| 0–10 cm | 151.29 | 1,409.70 | 0.07 | 1.04 | 4.0 | 9.3:1 |
| 10–20 cm | 415.67 | 2,656.8 | 0.05 | 5.53 | 5.86 | 6.4:1 |
| 20–30 cm | 411.83 | 1,579.04 | 0.13 | 12.77 | 3.13 | 3.8:1 |
| Totals: | 978.89 | 5,654.61 | 0.25 | 19.34 | 12.99 | |
| Site Percentage:[1] | 8.10 | 65.83 | 0.0029 | 0.23 | 0.15 | |
| SCII-1319: | | | | | | |
| 0–10 cm | 136.00 | 2,859.44 | 6.55 | 6.31 | 6.27 | 20.9:1 |
| 10–20 cm | 1,457.92 | 17,333.07 | 17.12 | 15.87 | 19.28 | 11.9:1 |
| 20–30 cm | 5,051.38 | 26,837.13 | 83.42 | 90.49 | 95.84 | 5.3:1 |
| 30–40 cm | 7,036.14 | 12,882.62 | 79.25 | 207.44 | 69.35 | 1.8:1 |
| Totals: | 13,682.04 | 59,912.26 | 186.35 | 320.11 | 190.74 | 1.8:1 |
| Site Percentage:[1] | 16.63 | 72.82 | 0.23 | 0.39 | 0.23 | |
| SCII-1325: | | | | | | |
| 0–10 cm | 157.55 | 1,864.11 | 1.92 | 6.65 | 22.93 | 11.8:1 |
| 10–20 cm | 689.65 | 6,533.00 | 6.09 | 10.28 | 62.01 | 9.5:1 |
| 20–30 cm | 965.94 | 6,675.00 | 3.10 | 75.10 | 37.96 | 6.9:1 |
| 30–40 cm | 590.79 | 5,085.00 | 11.35 | 17.87 | 17.07 | 8.6:1 |
| 40–50 cm | 572.64 | 2,885.00 | 10.87 | 34.35 | 7.83 | 5.0:1 |
| 50–60 cm | 68.04 | 289.58 | 0.83 | 00.00 | 0.85 | 4.3:1 |
| Totals: | 3,044.61 | 23,331.69 | 34.16 | 144.25 | 148.65 | |
| Site Percentage:[1] | 8.78 | 67.31 | 0.10 | 0.42 | 0.43 | |

[1]Percentages do not sum to 100% because these figures are not based on the total weight of all dietary elements and other midden constituents.

1961:24–25), contributed the largest proportion of shell to the middens. Sea urchin remains are of the purple sea urchin *(Strongylocentrotus purpuratus)*. It may be assumed that essentially all mammal bone was derived from sea mammals; the island has no indigenous mammals larger than the Channel Islands Fox *(Urocyon littoralis)*. There is no archaeological evidence on San Clemente Island indicating that this species was used for food. Fish bones frequently can be identified from the spines, vertebrae, syncranial bones, and other elements found in the middens. Table 1 presents the weight and percentage of the five classes of faunal remains by site and stratigraphic level.

The high proportion of tegula shell is striking. Table 1 shows that tegula shell ranges from 67.31% to 72.82% of all dietary elements by weight. Uncritical assessment of these figures may lead to unwarranted conclusions. One must approach reconstruction of prehistoric diet from midden remains with a number of cautions in mind. Among these is recognition that the sheer frequency or proportional representation of a species is not necessarily an accurate index of economic importance. Although a midden may contain only a few sea mammal bones, for example, the subsistence yield of this resource might have been greater than the combined yield of a more abundant faunal class such as shell.

Reconstruction of dietary yield from archaeological shell samples requires attention to several problems. The fragmentary nature of midden shells frequently frustrates the task of determining the MNI (minimum number of individuals) represented by a shell sample. Frequently, MNI must be estimated on the basis of shell weight. Estimates of this type must recognize that after deposition in a midden, shell may be transformed by physio-chemical processes. Leaching of carbonates may reduce the weight of shells (Kent 1988:9–16), with obvious implications for MNI figures based upon weight.

Tegula and black abalone shells, both fresh and midden specimens, were examined to estimate possible leaching effects, and to derive MNI estimates based upon shell weight. Comparison of the weight of fresh and midden shells of equal size shows that midden shells have lost approximately 3–4% of their weight, presumably as a result of the dissolution of carbonates from the latter. This estimate should be applied with caution, however, since leaching effects may vary with the age of sites.

A sample of 65 living tegula of various sizes was collected from a tide pool on San Clemente Island. These were boiled in water for 10 min to remove these small organisms from their shells. Although cooking may result in a slight reduction of flesh weight, it was assumed that this loss would be no greater than the loss caused by prizing the organisms out of broken shells. Weight of cooked flesh averaged 0.47 gm. Average shell weight was 2.59 gm. Applying a 4% reduction for shell leaching gives an estimated average weight for archaeological shell specimens of 2.49 gm. Using this average, 2,267 individual tegula are represented by the total weight of tegula shell in site SCII-1318 (Table 1). At an average flesh weight of 0.47 gm per organism, 2,267 tegula would yield 1,065.49 gm (2.34 lbs) of meat. Applying the same calculations, site SCII-1319 yields 24,061.15 organisms, producing 11,308.74 gm (24.92 lbs) of meat; site SCII–1325 yields 9,370.16 organisms, producing 4,403.97 gm (9.71 lbs) of meat.

As in the case of tegula shell, it is possible to estimate the meat yield of a sample of abalone shell. This estimate can be made by determining the MNI represented by the sample of midden shell, and the meat yield of this number of individuals. Once again, living populations afford a partial basis for yield estimates. Leighton and Boolootian (1963:237) provide two slightly different formulas for estimating the soft-tissue weight of the black abalone from shell length measurements. These data derive from studies at Point Dume and the Palos Verdes Peninsula, southern California. Both formulas were obtained from regression analyses of body weight on shell length. Reflecting slight differences in the size range of the two abalone populations, the Point Dume formula yields a fractionally more conservative estimate; i.e., body weight tends to be slightly less in relation to shell size when compared to the Palos Verdes population. Selecting the more conservative measure, the Point Dume formula is:

$$\log W = 3.465 \log L - 4.668$$

(W = soft-tissue weight [gm]; L = shell length [mm])

The formula is reported to have an error factor of +/–6% over a range of shell lengths from 50–120 mm. It is not clear why this formula was employed instead of standard allometric formulas (e.g., $Y = aX^b$, $\log Y = b(\log X) + \log a$), but Leighton and Boolootian's data offer one method for estimating meat yield from shell length.

Recent studies by the author and others of midden shells and living abalones on San Clemente Island are also useful for estimating meat yields. During 1990, information was collected on shell length and soft tissue weight of 111 living black abalones from three contiguous areas on the island's west shore.[2] Abalones of all sizes were taken from the intertidal zone in the order in which they were encountered. The shell length of each specimen was recorded, along with the weight of the foot and viscera (foot weight + viscera weight = total soft tissue weight). Information was also collected on abalone shell length and weight from middens.

Data from living specimens offer only a partial solution to the problem of fragmentary shells in middens. Estimates of abalone meat yield from midden remains involve several factors. Shell length data offer an approach to establishing MNI counts. Black abalone shells excavated from the sites discussed here ranged from about 50–130 mm, although few shells exceeded 80 mm. Unfortunately, no systematic measurements of shell lengths were made during excavation. Recently collected shell data, however, afford a means of characterizing abalone shell length in the island's midden sites.

Measurements of whole abalone shells are available from three archaeological sites on the island. Abalone measurements were taken recently at two midden sites, SCII–315 and SCII–310, on the west shore of San Clemente Island. At site SA61 (SCII–315), 51 whole specimens were recovered and measured, with a mean length of 59.8 mm and a standard deviation of 18.7 mm. At site SCII–310, 86 whole specimens were recovered with a mean length of 69.2 mm and a standard deviation of 14 mm. A third sample of shells was obtained from a refuse deposit within

a prehistoric pithouse at the Nursery site (SCII–1215; Salls and Raab 1991). This deposit yielded 111 shells with a mean length of 75.2 mm and a standard deviation of 18.3 mm. These three archaeological shell samples have a modal length of 70–80 mm.

For purposes of estimating meat yield of prehistoric specimens, a modal shell length of 75 mm seems reasonable. Using the Leighton and Boolootian (1963:237) formula presented earlier, a meat weight of 67.47 gm is obtained for a shell length of 75 mm. The author's study of living black abalone, however, produced a somewhat different result: average soft tissue weight for specimens ranging 70–79 mm (n = 6) was 40.92 gm. It may be appropriate, in this case, to use 40.92 gm as the average soft tissue weight of an abalone with a shell 75 mm long. This figure is derived empirically from an extant local population, and the formula presented by Leighton and Boolootian may tend to overestimate the soft-tissue weight of specimens below 100–120 mm. An estimate of total meat yield may be obtained by multiplying the 40.92 gm average body weight by the estimated MNI represented by a shell sample.

In order to estimate MNI, it is necessary to know the weight of a 75 mm long shell. Fifty-five abalone shells were collected by the author from deflating midden deposits at the Eel Point site (SCII–43) in order to obtain information on length and weight characteristics. Shells 70–80 mm long (n = 5) averaged 25 gm. A weight of 25 gm was therefore used to estimate the MNI represented in Table 1, and the number of specimens thus derived were multiplied by 40.92 gm (soft-tissue weight). Estimates of total meat yield for turban snails and abalone for each of the levels of the three midden sites are presented in Table 2.

Another factor to be considered here is whether the whole organism was eaten or, like modern consumers of abalone, prehistoric peoples ate only the muscular foot. Clearly, total dietary yield would vary, depending on the portion eaten. The present estimates are of *maximum possible meat yield;* i.e., consumption of all soft tissue. I am aware of at least one ethnographic instance in which all soft tissue was apparently consumed (Meehan 1982:5–6). There appears to be no nutritional basis for ruling out such a practice.

On the basis of meat yield, abalones appear to be the key shellfish component of the middens, although this conclusion might not be apparent from either casual observation of the middens themselves or examining the high percentages of tegula shell in Table 1. Of resources gathered in the intertidal zone, abalones have the greatest subsistence yield. Tegula were being intensively collected as well, making a secondary subsistence contribution. The importance of abalone procurement within the subsistence base may be examined in another fashion. A factor analysis (*Systat* statistical program, V. 3.0) of data presented in Table 1 creates a statistical model in which it is possible to estimate the influence of each faunal constituent on each of the other constituents. This procedure is a principal components analysis, which determines the total amount of variance explained by each of the faunal constituents (components) within Table 1. Variance estimates are derived from regression coefficients for all variables in Table 1. This analysis is helpful in determining which dietary components influence the values of others within the matrix. The results of this analysis are that the abalone component

TABLE 2.—Estimated total meat yield (gm) for *Tegula* and *Haliotis*.

| Site SCII–1318: | *Haliotis* | *Tegula* |
|---|---|---|
| 0–10 cm | 247.63 | 266.00 |
| 10–20 cm | 680.37 | 501.49 |
| 20–30 cm | 672.72 | 298.05 |
| Totals: | 1,600.72 | 1,065.54 |
| Site SCII–1319: | | |
| 0–10 cm | 222.60 | 539.73 |
| 10–20 cm | 2,386.32 | 3,271.70 |
| 20–30 cm | 8,268.10 | 5,065.64 |
| 30–40 cm | 11,516.75 | 2,431.66 |
| Totals: | 22,393.77 | 11,308.73 |
| Site SCII–1325: | | |
| 0–10 cm | 257.88 | 351.86 |
| 10–20 cm | 1,128.82 | 1,233.14 |
| 20–30 cm | 1,581.05 | 1,259.94 |
| 30–40 cm | 967.00 | 959.82 |
| 40–50 cm | 937.30 | 544.55 |
| 50–60 cm | 111.37 | 54.55 |
| Totals: | 4,983.42 | 4,403.86 |

always accounts for the greatest percentage of variance explained: 57.89% for site SCII–1318 (followed by tegula at 42.12%); 80.56% for site SCII-1319 (followed by tegula at 18.32%); and 61.96% for site SCII–1325 (followed by 21.23% for tegula). In other words, variation in the contents of the middens is most strongly correlated with the amount of abalone shell present. These data suggest that abalone collecting was particularly important in structuring the whole shellfish collecting pattern.

It is hardly surprising that abalones and tegula account for most of the variance in Table 1, given the fractional representation of the remaining midden constituents. It is interesting, however, that abalones account for the greatest percentage of variance explained, despite the fact that shell weights for tegula are higher than those of abalones. These data suggest that dietary remains from the samples examined are keyed in their variability to the amount of abalone shell in the middens. Despite the significant contribution of tegula to the subsistence base, abalone seem to play a pivotal role in structuring the subsistence pattern both as revealed by the factor analysis and the estimated meat yields.

## OPTIMAL FORAGING

The observed data conform well to an optimal foraging model of subsistence:

> The range of foods eaten by different populations of animals or human hunter-gatherers depends both upon the ''value'' of available, edible resources ...''Value'' may be defined as the net energy yield of a resource per unit of ''handling time;'' for human hunter-gatherers, the latter includes time devoted to the capture, retrieval and processing of different foods. The result is that most foragers take an optimal range of resources, or optimal dietary breadth ... When is a particular resource included in (added to) the optimal dietary breadth? This appears to depend primarily on the ''value'' of that item, and both the abundance and the value of more valuable resources ... Thus, the value (handling time) of an item is the major factor, and abundance a secondary factor, in determining the resources ''selected'' to constitute the optimal diet (Yesner 1981:150).

Moreover:

> Large, carnivorous foragers, such as humans, tend to exploit their environments in a ''fine-grained'' fashion, encountering and exploiting resources in the proportions in which they actually occur ... Thus, for those species that are harvested, an optimal forager will take them in amounts representative of the biomass of that species in the (local) environment. In other words, while the spectrum of species eaten may not be a representative sample of all species available, among those that are eaten, harvested biomass should be proportional to that in the natural environment (Yesner 1981:150).

Although the present discussion focuses on the five midden constituents presented in Table 1, the middens actually contain a broad spectrum of food remains from the intertidal zone, albeit at quite low frequencies. We find remains of limpets, chitons, crabs, and birds, for example. The middens appear to contain essentially every edible tide pool species likely to have been taken by a ''fine-grained'' mode of foraging. For this reason it seems likely that the relative proportions of abalones and tegula in the middens reflect the availability of these species in the tide pool environment, an observation reinforced by the present intertidal ecology. The foraging strategy employed by the prehistoric tidepool gleaners appears to reflect the fact that, of all species available, only abalones and tegula could be collected in sufficient quantities to meet dietary needs.

The abalone is clearly the single most ''valuable'' species represented in the middens; i.e., this species would yield the greatest subsistence return in relation to the ''handling time'' involved in procurement. The black abalone, as discussed earlier, is a ''meat package'' of substantial size. This species, being an intertidal form, is also relatively easy to exploit; they are readily collected on rocks exposed during low tides. This food resource is also easily exhausted. Even a small group of foragers, given daily collecting trips, could quickly strip a sizable section of the shore of abalone. This suggests that the optimal dietary breadth was dynamic; i.e., was determined not only in relation to the types of food resources encountered in the tide pools, but also by the impact of the foragers themselves.

Any decrease in the availability of abalone would likely change the value of tegula in the dietary spectrum. These snails individually represent quite small food items; on this basis, their dietary value may appear to be minimal at best. On the basis of the optimal foraging model, however, their value as a food item would be determined in relation to their abundance, the availability of food items of higher value, and their handling cost. The imposing presence of tegula in the middens clearly indicates that they were abundant. In the event of an insufficient supply of higher value shellfish (abalone), their abundance alone may recommend tegula as a food item. The ease with which tegula may be obtained reduces their handling time, thus increasing their relative value. These snails are easily collected by hand in tide pools during low tide. Ease of procurement also means that most members of the population could participate in economic production without special skills or equipment. Significantly, children and the aged, persons otherwise marginal to the economy, can make significant contributions to the diet by collecting shellfish. Although nutritional data on tegula are lacking, as algae-consuming gastropods, it seems reasonable to assume that they would yield nutritional benefits on par with abalone (c.f. Erlandson 1988:104).

But what about the handling time involved in extracting food from such a small organism? At first this factor might seem to weigh against the dietary value of tegula. An interesting comparison can be made here to research by Yesner (1981:155) on prehistoric Aleut middens:

> In addition, there appears to have been selection among shellfish species. For example, while conch-type gastropods (periwinkles and whelks) are relatively abundant on the strand flat, comprising about twenty per cent of the shellfish biomass, they are practically non-existent in the middens, and there is no ethnographic evidence that they were ever significant dietary items. These species probably fall outside the optimal diet, owing to the large time and energy expenditure required for their processing (handling costs). They are smaller than other shellfish species, and picks would have been required to retrieve the individually small amount of (low calorie) meat from them.

From this perspective, it may be surprising that tegula were exploited at all. The midden evidence from San Clemente Island indicates, however, that other ways of handling small gastropods in a cost effective manner are available. Nearly all tegula shell from the middens has been crushed. Processed in this fashion, tegula do not need to be extracted as individual organisms. Instead, the crushed organisms are freed from their shells, and can be cooked in bulk. The result is a food product that can be obtained with relatively economical handling costs.

The intertidal ecosystem of San Clemente Island's west shore, then, offered certain resource potentials for shellfish exploitation. The fashion in which this ecosystem was utilized conforms well to an optimal foraging model of subsistence. Black abalone exploitation was the single most valuable component of the shellfish economy. Since this resource was easily depleted, however, the dietary breadth

was necessarily dynamic, with black turban snails collected in large quantities to supplement dwindling supplies of abalones. This pattern is indicated in the shifting ratios of tegula to abalone meat yield from the lower to the upper levels of the middens (Table 1).

If the conclusions presented here are correct, other aspects of the prehistoric ecosystem come into focus. Intensive collecting for food items within the intertidal zone, even by small human populations, easily has the capacity to exhaust the supply of species such as abalone and tegula. As noted earlier, Yatsko (1987a) has documented hundreds of shell midden sites of the kind described here on the coastal terraces of San Clemente Island. Frequent residential moves are perhaps the only means by which a hunting-and-gathering society can cope with the easily depleted resources of the intertidal zone on San Clemente Island. High mobility of this type could account for the thousands of small midden sites on the island's west shore. This is a settlement dynamic similar to that described by Sanger (1988:91).

The intensity of prehistoric abalone collecting on San Clemente Island is suggested by the modal size of midden specimens, which ranged between 70 and 80 mm. As noted earlier, abalones are emergent when they reach a length of 75–100 mm (Ault 1985:6); i.e., they leave the protection of rock crevices to forage for food on exposed surfaces. The midden specimens suggest that few postemergent abalones escaped human predators.

## CONCLUSIONS

Detailed analysis of aboriginal shell middens on San Clemente Island indicates that exploitation of shellfish species conforms well to predictions derived from an optimal foraging model of subsistence. Although these middens are composed largely of tegula shells, estimates of meat yield indicate that the black abalone provided the greatest proportion of food. A factor analysis shows that abalone shell weights best explain variance in the composition of the total shell assemblages. An aboriginal strategy of shellfish collecting is proposed in which an optimal dietary breadth responds dynamically to rapid depletion of abalones (highest value food source) through exploitation of tegula, a second rank but relatively low-cost food source.

## NOTES

[1]The research described here is part of a five-year cooperative research agreement between the Center for Public Archaeology, California State University, Northridge and the Natural Resources Office, North Island Naval Air Station, San Diego, California. San Clemente Island has been a Naval reservation since 1934. Prehistoric settlement patterning and human ecology are major topics addressed within a research design (Raab and Yatsko 1990a) being implemented through site surveys, specialized site testing programs, and archaeological field schools.

[2]The abalone studies were conducted under terms of a scientific collecting permit issued by the California State Department of Fish and Game. Field reports on several hundred living abalones on San Clemente Island were provided by Mr. Peter Haaker of the California State Department of Fish and Game.

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# BOOK REVIEW

**Islands, Plants, and Polynesians: An Introduction to Polynesian Ethnobotany.** Paul Alan Cox and Sandra Anne Banack (editors). Portland, Oregon: Dioscorides Press, 1991. Pp. 240, 16 photos. $34.95 (cloth). ISBN 0–931146–18–6.

*Islands, Plants and Polynesians* is a collection of papers originally given at a symposium entitled ''Plants and Man in Polynesia'' in Laie, Hawaii, in December 1988. The result is a beautifully produced book containing a wealth of information about Polynesian ethnobotany. Throughout, one appreciates the ingenuity the Polynesians have displayed in adapting to their island environments. Especially striking are the influences of their remarkable sea voyages in shaping the botanical and cultural landscapes of this area.

Polynesia is roughly defined as the area within a triangle circumscribed by Hawaii, Easter Island, and New Zealand. Emphasis is placed upon, but not limited to, the tropical island ecosystems of this region. The volume begins with Raymond Fosberg's introduction to Polynesian plant environments, in which he describes their physical characteristics and reconstructs pre–Polynesian, pre–European, and post–European landscapes and biota. Sandra Anne Banack follows with an account of the plant materials used in Polynesian voyaging, from boat construction to ceremonial offerings. Patterns of Polynesian plant introductions before or shortly after European contact are detailed by Arthur Whistler, who documents 72 plant species intentionally introduced by aboriginal Polynesians and another 12 which were possibly introduced intentionally. Douglas Yen addresses the origins of Polynesian cultivars and agricultural systems, discussing the influences of Southeast Asia and New Guinea on Polynesian agricultural species and practices. Karl Rensch provides an example of the use of linguistic evidence in deducing plant origins and migrations, focusing specifically on the vernacular names for the sweet potato. Patrick Kirch characterizes aboriginal Polynesian agricultural systems and describes their evolution and modification through time. The Polynesian uses of seaweeds are detailed by Isabella Abbott. Paul Cox provides an insightful discussion of Polynesian herbal medicine, touching not only on some important plant species utilized, but examining Polynesian theories of disease causation, the role of healers in Polynesian society, and the evidence for and against the autochthonous origins of Polynesian herbalism. The ethnobotany of Kava *(Piper methysticum),* an inebrient used throughout Polynesia, is discussed in detail by Vincent Lebot. Finally, Diane Ragone gives an account of the distribution, uses, and preservation methods for breadfruit *(Artocarpus altilis)* in the south Pacific.

There is much here to interest both the botanist and anthropologist. Scientific names as well as local names are used accurately throughout the text along with the plant family, a welcome practice that facilitates accurate identification and comparison of botanical entities. An index to scientific names and Polynesian words is given. The book is handsomely produced, reasonably priced, and a pleasure to read. I found very few errors. Many of the papers emphasize the

need to document the ethnobotanical lore of Polynesia before both the plants and the knowledge of how to use them are irrevocably lost. This book is an outstanding contribution that adds greatly to our knowledge of Polynesian plants and peoples, and points the way toward new directions for study in Polynesian ethnobotany.

Lynn Bohs
Department of Biology
University of Utah
Salt Lake City, Utah 84112

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# TWO PREHISTORIC PUEBLOAN AVIFAUNAS FROM THE PECOS VALLEY, SOUTHEASTERN NEW MEXICO

STEVEN D. EMSLIE
*Environmental Studies Department*
*University of California*
*Santa Cruz, CA 95064*

JOHN D. SPETH
*Museum of Anthropology*
*University of Michigan*
*Ann Arbor, MI 48109*

REGGE N. WISEMAN
*Office of Archaeological Studies*
*Museum of New Mexico*
*Santa Fe, NM 87504*

ABSTRACT.—We present identification of avifaunal remains from two late prehistoric sites in the Pecos Valley, Chaves County, southeastern New Mexico. The Henderson site (LA-1549), a 50–70 room pueblo, and the Rocky Arroyo site (LA-25277), a small pitroom community of only three or four structures, were contemporaneous or nearly so, with principal occupation most likely beginning ca. A.D. 1250–1275 and ending A.D. 1325. At least 48 taxa (genera and species) are represented in these avifaunas, including the easternmost record known for Scarlet Macaw *(Ara macao)* in the prehistoric Southwest. All other taxa presently occur in southern New Mexico, but some only during migration and in winter, suggesting that exploitation of many aquatic species (e.g., geese and ducks) was occurring during the winter months. Comparison of these avifaunas indicates site-specific differences in the use of birds, with a greater emphasis on aquatic taxa at Rocky Arroyo. The avifaunas also support the hypothesis that prehistoric Pueblo Indians practiced site-specific hunting specializations for particular species or groups of birds. Trade (directly or indirectly) with Mesoamerica is indicated by the presence of the Scarlet Macaw and possibly also by the presence of the cardinal.

RESUMEN.—Presentamos la identificación de restos de avifauna de dos sitios prehistóricos tardíos en el Valle de Pecos, Condado de Chaves, al sureste de Nuevo México. El Sitio Henderson (LA-1549), un pueblo con 50 a 70 cuartos, y el Sitio Rocky Arroyo (LA-25277), una pequeña comunidad de cuartos-foso con solo tres o cuatro estructuras, fueron aproximadamente contemporáneos; su ocupación principal se dio muy probablemente entre circa 1250/1275-1325. Por los menos 48 taxa (géneros y especies) están representados en estas avifaunas, incluyendo el registro más oriental conocido de la guacamaya escarlata *(Ara macao)* en el Suroeste de los E.E.U.U. en el período prehistórico. Todos los demás taxa

se encuentran actualmente en el sur de Nuevo México, pero algunos de ellos están presentes solamente durante las migraciones y el invierno, lo cual sugiere que el aprovechamiento de varias especies acuáticas (gansos y patos) se hacía durante los meses invernales. La comparación entre estas avifaunas indica diferencias específicas a cada sitio en el uso de aves, con un mayor énfasis en los taxa acuáticos en Rocky Arroyo. Las avifaunas también apoyan la hipótesis de que los indígenas Pueblo prehispánicos practicaban especializaciones de caza, específicas a cada sitio, para especies o grupos de aves particulares. El comercio (directo o indirecto) con Mesoamérica es indicado por la presencia de la guacamaya escarlata, y posiblemente también por la presencia del cardenal.

RESUME.—Nous présentons l'identification de restes d'oiseaux venant de deux sites préhistoriques de la vallée du Pécos (comté de Chaves, au Sud-Est du Nouveau-Mexique). Le site d'Henderson (LA-1549), un pueblo de 50 à 70 pieces, et celui de Rocky Arroyo (LA-25277), une petite communauté de trois ou quatre structures semisouterraines, étaient à peu près contemporains, leur principale période d'occupation se situant très probablement entre 1250-75 et 1325 ap J.C. Au moins 48 genres et espèces sont représentés parmi ces oiseaux, y-compris l'occurence la plus orientale connue dans le Sud-Ouest préhistorique pour le Ara écarlate *(Ara macao)*. Tous les autres types se trouvent à présent au sud du Nouveau-Mexique, mais quelques-uns seulement pendant les migrations et en hiver, ce qui suggère que l'exploitation de nombreuses espèces aquatiques (oies et canards) avait lieu pendant les mois d'hiver. La comparaison de ces restes d'oiseaux indique des différences spécifiques à chaque site dans l'utilisation de ceux-ci, en particulier un usage plus intensif des types aquatiques à Rocky Arroyo, et permet de supporter l'hypothèse selon laquelle les Indiens Pueblos préhistoriques pratiquaient une chasse spécialisée de groupes et d'espèces d'oiseaux spécifiques à chaque site. Le commerce (direct ou indirect) avec le Mexique est attesté par la présence du Ara écarlate, et peut-être par celle du cardinal.

## INTRODUCTION

The Henderson (LA-1549) and Rocky Arroyo (LA-25277) sites are two late prehistoric (ca. A.D. 1250–1400) puebloan villages located about 8 km apart in the Hondo River drainage, a major western tributary of the Pecos River, Chaves County, southeastern New Mexico (Fig. 1). The Henderson site, partly excavated by personnel from the Museum of Anthropology of the University of Michigan in 1980 and 1981, is situated on a low limestone ridge that flanks the south edge of the Hondo where this drainage first enters the alluvial flats of the Pecos Valley. The elevation of the Henderson site is about 1,186 m. The Rocky Arroyo site, at an elevation of about 1,133 m, is located in the alluvial flats of the Pecos Valley almost due east of Henderson, about 100 m east of the Rocky Arroyo drainage and approximately 1 km upstream (south) from the confluence of this small intermittent drainage with the old channel of the Hondo.[1] Rock Arroyo was excavated almost in its entirety during the 1970s by amateurs belonging to the Chaves County Archaeological Society (CCAS). Small-scale salvage excavations in one of the structures at Rocky Arroyo were conducted there in 1980 by one of us (RNW).

FIG. 1.—Location of the Henderson site (LA-1549) and Rocky Arroyo site (LA-25277), Chaves County (shown by dashed line), southeastern New Mexico.

The present-day vegetation in the area of the Henderson and Rocky Arroyo sites has been altered significantly over the past century by overgrazing, land-leveling, channelizing and damming the Hondo River, and lowering the local water table for irrigation farming and for meeting the domestic and commercial needs of the growing city of Roswell. These changes have reduced the local vegetation cover, and favored increases in more drought-resistant species. Today, the less disturbed open flats and limestone ridges in the area support a variety of grasses, especially the gramas (black, *Bouteloua eriopoda;* blue, *B. gracilis;* sideoats, *B. curtipendula)* and tobosa *(Hilaria mutica),* while dense growths of sacaton *(Sporobolus* sp.) occur along the margins of the normally dry channels of the Hondo and Rocky Arroyo drainages. Other plants common today in the area include broom snakeweed *(Gutierrezia sarothrae),* prickly pear and cholla cactus *(Opuntia* spp.), yucca *(Yucca* spp.), greasewood *(Sarcobatus* sp.), four-wing salt bush *(Atriplex canescens),* and mesquite *(Prosopis* spp.). Very few trees grow near the sites today; most were planted near ranch headquarters as ornamentals or for shade. Wild species are found primarily near the Henderson site, where they grow in a narrow band along the channel of the Hondo. Among the more common trees are cottonwood *(Populus* sp.), hackberry *(Celtis* sp.), wild walnut *(Juglans* sp.), and salt cedar *(Tamarix* sp.), the last introduced historically to control erosion.

The climate of the Roswell area today is semiarid. Roswell receives about 295 mm of rain annually (Houghton 1974:802). Winters are relatively dry, with the period from November through March receiving about 58 mm of precipitation. Therefore over 80% (i.e., 237 mm) of the average annual rainfall occurs during the seven months from April to October. Rains come in two distinct periods. The first is in May, followed by a slight decline in June. The principal rainy season, often characterized by intense thunderstorms, occurs from July through September; nearly 45% of the annual precipitation falls during these three months.

Summers in Roswell are warm, with average daily maxima exceeding 32°C (90°F) from June through August. Winters are mild, with average daily highs, even in January, of 12.8°C (55.1°F). Average minimum daily temperatures drop below freezing from mid-November through mid-March, but rarely drop to 0°F. The average length of the frost-free season, 206 days, extends from 7 April to 30 October (Von Eschen 1961:51).

The excavation and salvage operations at the Henderson and Rocky Arroyo sites yielded a comparatively large sample of avian remains: 548 specimens representing at least 120 individuals of at least 48 taxa. We present identifications of these avifaunas, which provide information on the use of birds by the late prehistoric inhabitants of this fascinating but poorly known region that borders the eastern edge of the Greater Southwest and western Great Plains.

## SITE DESCRIPTION AND METHODS

*The Henderson site.*—The Henderson site is an E-shaped adobe pueblo of 50–70 large, rectangular, single-story rooms (Fig. 2). The room blocks are arranged with the longest or main bar of the "E" oriented roughly 60 degrees west of true north and the shorter bars (referred to henceforth as the east, center, and west bars) extending to the south (i.e., away from the Hondo). The open spaces enclosed between the shorter bars form small plaza areas, designated the east and west plazas. No evidence of a kiva has been found in either plaza, and none of the rooms tested to date shows evidence of specialized ceremonial functions.

Most of the excavations at Henderson have been confined to rooms in the east and center bars, and to the south end of the east plaza (Fig. 2, Fig. 3, and Fig. 4). With the notable exception of a series of subfloor burials, which yielded a diversity of grave accompaniments (see Rocek and Speth 1986), very few artifacts were found in situ on room floors or cached in pits or other features. Instead, most archaeological materials (e.g., lithics, sherds, animal bones, charcoal) were found randomly dispersed throughout room fill. Only two clearly in situ ashy midden deposits were encountered, one nearly filling room C-5 in the center bar, the other toward the south end of the east plaza. These two deposits produced most of the animal bones at Henderson, including many of the bird remains reported here.

The midden in the east plaza deserves further comment. This deposit appears to represent the remains of a huge roasting complex, located in or adjacent to

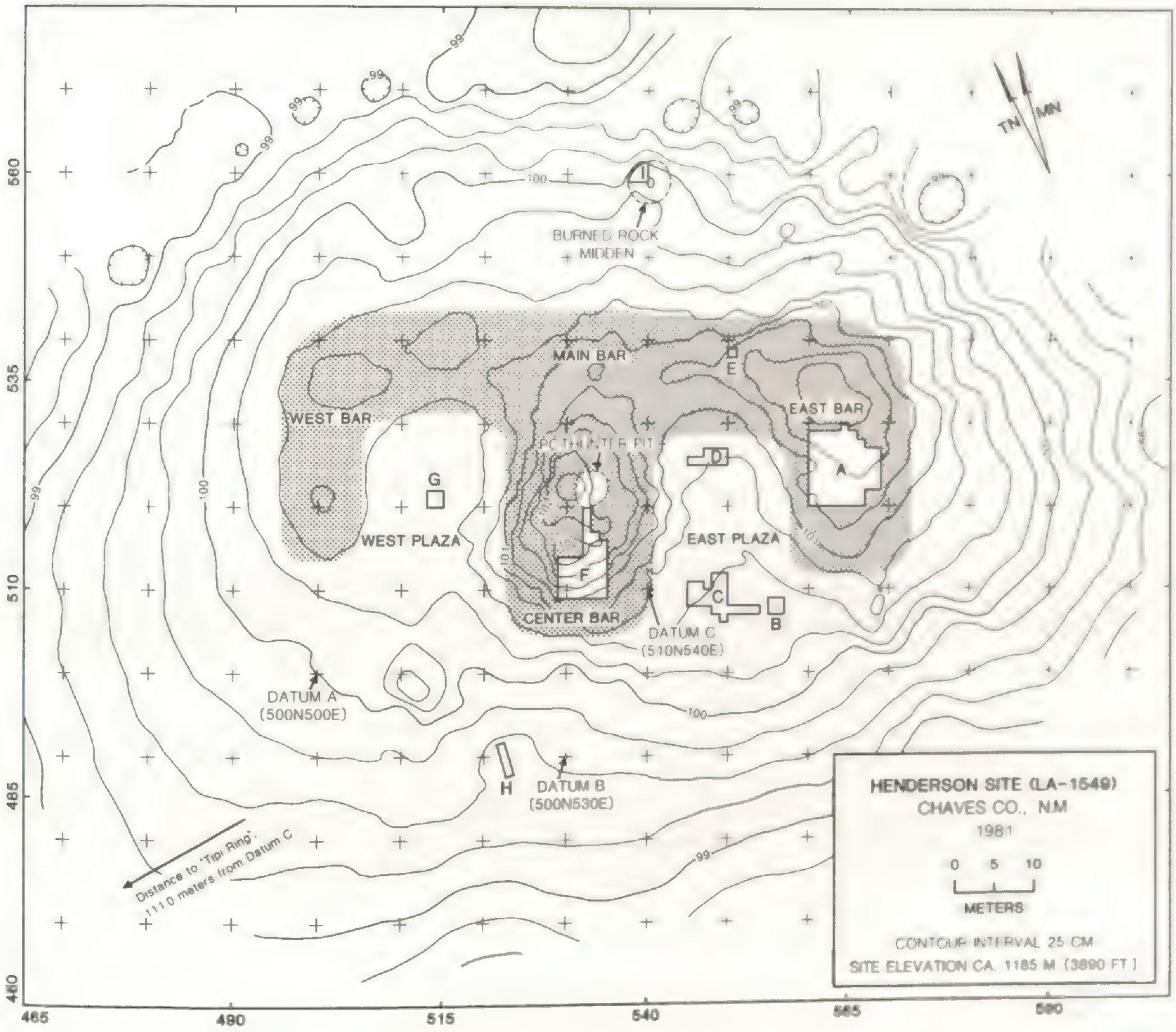


FIG. 2.—Map of Henderson site (LA-1549) showing location of principal excavation units.

a shallow, natural gully in the bedrock that directly underlies the plaza surface. While the precise location of the original roasting feature has not been identified, its proximity is indicated by the large quantities of burned and fractured limestone rock, expedient heavy-duty limestone choppers and cleavers, dense ash and charcoal, and animal bones (including over two thousand bison bones) dumped into the gully. Much of this trash represents remains of activities carried out in the plaza, particularly the butchering and roasting of bison, but domestic trash from adjacent room blocks also appears to have been dumped into the gully as evidenced by large quantities of broken pottery and lithics, and debris from the manufacture of freshwater mussel shell ornaments.

*The Rocky Arroyo site.*—In contrast to the Henderson site, Rocky Arroyo consists of at least three large, deep rectangular pitrooms, irregularly spaced adjacent to an open midden-filled area, with no evidence of above-ground structures at the site (Fig. 5). The trash deposits and associated pitroom structures at Rocky Arroyo were almost completely excavated by the CCAS in the 1970s. The exca-

vators appear to have been systematic in their search for artifacts, screening much of the fill through quarter-inch mesh. Their excavations focused on three structures, two of which they emptied completely; they also excavated most of the associated midden deposits.

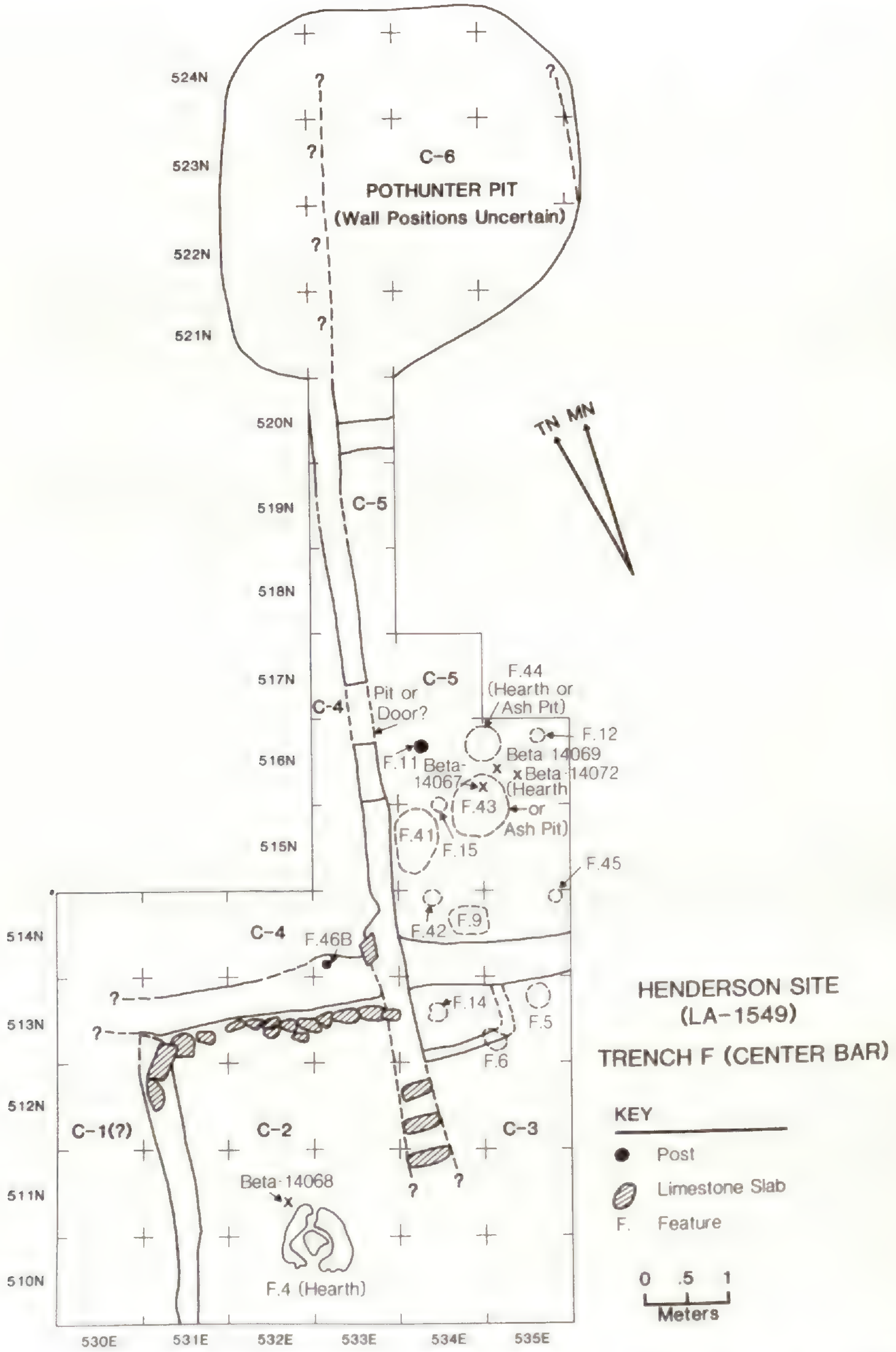


FIG. 3.—Plan of center bar at Henderson site (LA-1549) showing excavated rooms and features.

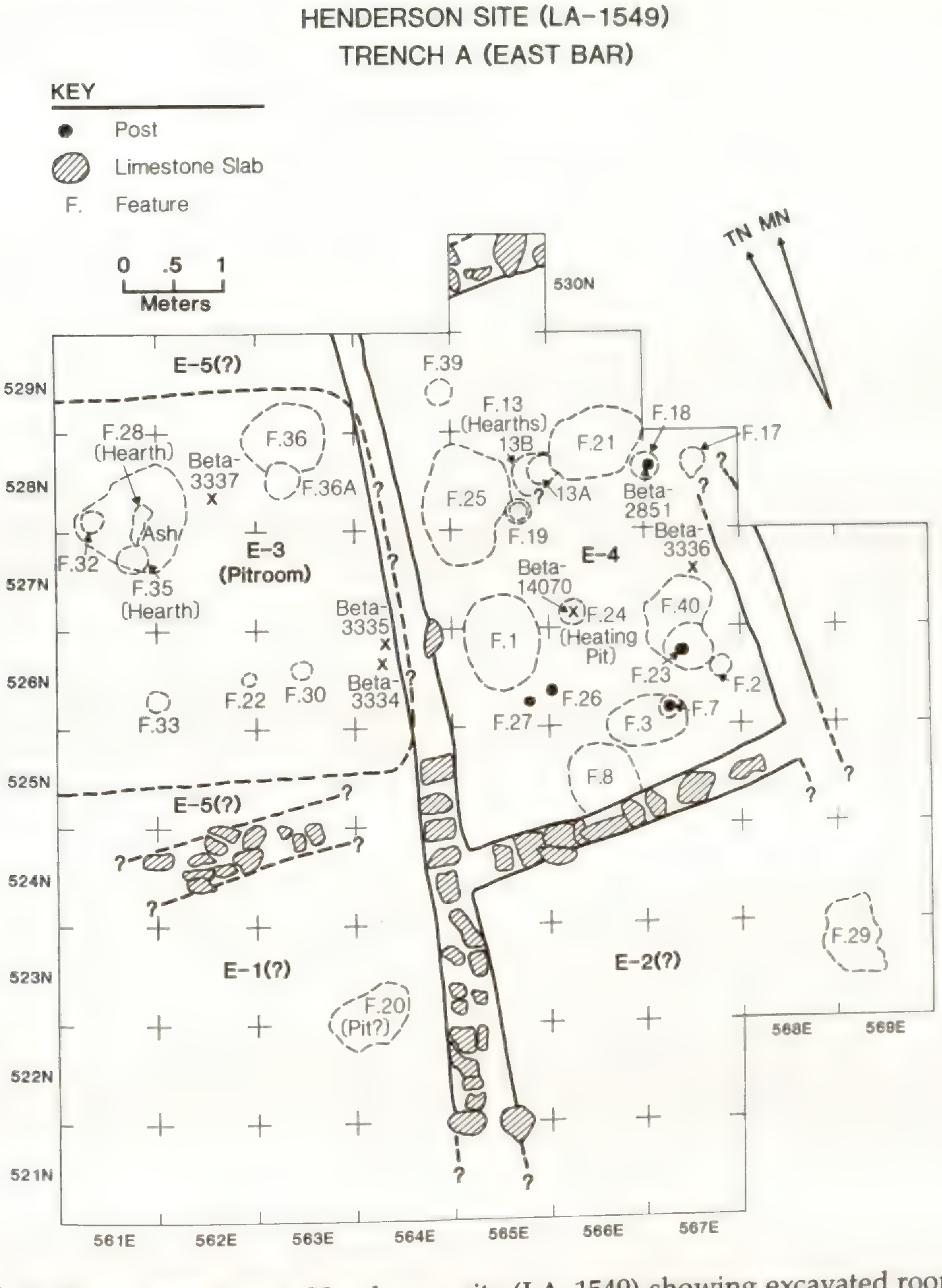


FIG. 4—Plan of east bar at Henderson site (LA-1549) showing excavated rooms and features.

The fate of the archaeological material recovered in these excavations is unknown, but faunal remains, as well as many human bones (mostly vertebrae and phalanges), lithics, sherds, and other debris were discarded and left in piles on the surface of the site. The excavators placed the bones into large metal tins, which they left near the structures where, presumably, the bones had been recovered; two of us (RNW and JDS) salvaged these materials and treated them with a polyvinyl-acetate preservative to prevent the bones from disintegrating.

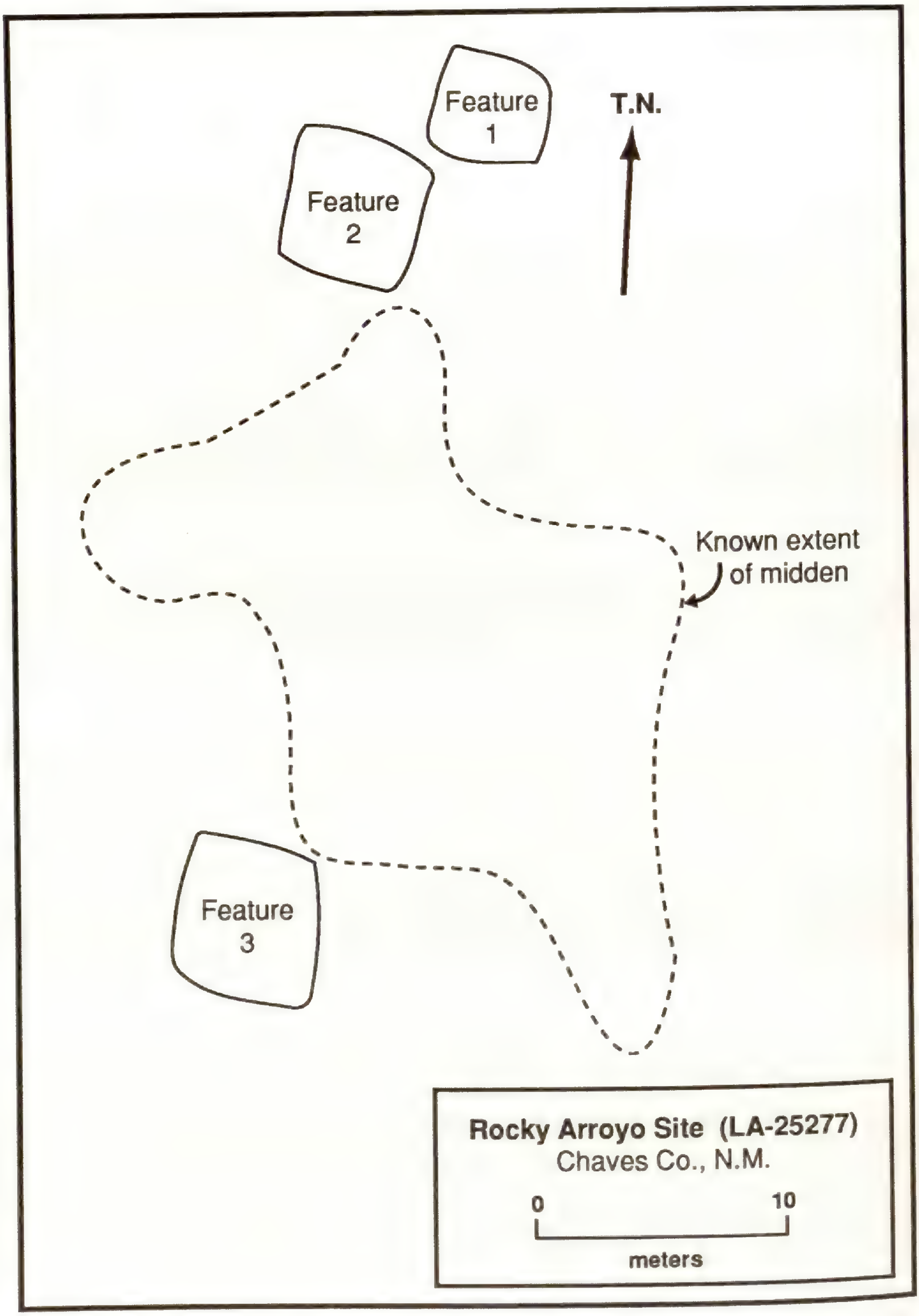


FIG. 5.—Sketch map of Rocky Arroyo site (LA-25277) showing approximate location of pitrooms and general midden deposits.

The biases in this faunal sample are difficult to assess. We are unable to determine with any certainty which bones came from structures and which came from extramural midden deposits, nor can we tell whether a tin contained bones from the structure nearest to it or from more distant ones as well. In addition, the comparatively small number of bones of small mammals and birds (e.g., rabbits, rodents, and passerines) suggests that either much of the deposits was not screened or that only larger bones were collected from the screens.

Fortunately, one of the three pithouses, Structure or Locus 2, was not totally emptied. A large wedge of undisturbed deposit was excavated by one of us (RNW) and all sediment processed by flotation and fine-screening using a 0.5 mm geological sieve. This sample contained thousands of well-preserved fish bones (including scales), as well as a wide array of other faunal remains, such as bison *(Bison* sp.), pronghorn *(Antilocapra americana)*, muskrats *(Ondatra zibethicus)*, and many rodent, rabbit, tortoise, and bird bones.

*Age and correlation.*—Ceramic evidence indicates that the Henderson and Rocky Arroyo sites date to the late prehistoric period. A series of radiocarbon and archaeomagnetic dates place the principal occupation at both sites between ca. A.D. 1250–1275 and A.D. 1325, with continuing but less intensive occupation or intermittent reoccupation of the Henderson site in the late 1300s or early 1400s (see Rocek and Speth 1986; Wiseman 1985).

While the ceramic assemblages from Henderson and Rocky Arroyo are virtually indistinguishable and suggest broadly equivalent ages for the two sites, the architectural differences between them—pithouses at Rocky Arroyo, above-ground adobe structures at Henderson—suggest that Rocky Arroyo may be slightly earlier than Henderson. However, in the absence of tree-ring dates or other criteria for precisely establishing the dates of the occupations, we cannot rule out the possibility that the architectural differences reflect ethnic, seasonal, or other factors rather than chronology.

*The faunal remains.*—Most faunal remains, including those of birds, from the Henderson site were collected from arbitrary 5 cm deep excavation units (1 m square grids), with all matrix sifted through quarter-inch mesh screens. Only a small number of avian specimens were recovered from flotation samples, although more than 300 large (>2 l) samples were processed from a wide variety of proveniences. A few Henderson avian specimens have complete provenience information written directly on them, denoting grid square and depth below a datum assigned an elevation of 100.00 m (e.g., 513N565E 101.20-101.15). Most bones from different units and archaeological features were assigned sequential "lot" numbers. These numbers are given for each identified bone listed in the Appendix table.[2]

All bones salvaged from the backdirt piles at Rocky Arroyo were assigned locus numbers based on the architectural or other feature nearest to where they were found (Fig. 5). Four such loci were identified, three of which (Loc. 1–3) are pitroom structures. Some bone found between Loc. 1 and 2 could not be assigned with confidence to either area and was labeled Loc. 1-2. Salvage exca-

vations (by RNW) of the undisturbed deposits in Locus or Structure 2 greatly enlarged the total faunal sample, although most material recovered was bison and fish bones. These bones were assigned lot numbers to represent their stratigraphic provenience.

All bird bones were identified (by SDE) at the Museum of Vertebrate Zoology, University of California, Berkeley.[3] Minimum numbers of individuals (MNI) for each taxon were determined by counting the most common element from one side and by morphologic comparisons of elements of different sides. The percentage of total number of identifiable specimens (NISP) per taxon was used to compare faunal samples by employing a test of equality and arcsine transformation to calculate a test statistic ($t_S$; Sokal and Rohlf 1969). We used this test to determine significant differences ($p<0.05$) in the percentage NISP by Order (intersite comparisons) and by skeletal element (intrasite comparisons) from Rocky Arroyo and Henderson. Comparisons of the proportions of wing versus leg elements by provenience were based on three paired elements for each category: radius, ulna, and carpometacarpus as wing elements because these bones support the majority of wing feathers, and femur, tibiotarsus, and tarsometatarsus as leg elements. We assumed no differential preservation of wing versus leg elements at these sites.

## DISCUSSION

At least 48 taxa (genera and species) are represented by these avifaunas. Except for the macaw *(Ara macao)*, all species are currently found in New Mexico, but many are migratory and occur in southern New Mexico primarily in the winter or spring and summer seasons (Table 1). The numerous aquatic taxa, especially from Rocky Arroyo, indicate the former presence of large rivers, marshes, and/or lakes. The Hondo River presently is dry most of the year as a result of damming and a lowering of the water table, but was a permanent stream in the late 1800s (Rocek and Speth 1986). Several species in the avifauna, including prairie falcon, scaled quail, and Chihuahuan raven, occur in open grasslands of the desert Southwest. 'Grasses and shrubs are the dominant vegetation of this semiarid region of New Mexico today (Rocek and Speth 1986).

The avifaunas reflect a much richer environment in the past than is present in this area of New Mexico today. This environment included a permanent source of water, the Hondo River, with associated wetlands and riparian habitats, and large, open grasslands. It is possible that some of the birds, particularly the aquatic species, were captured some distance away from the villages; if so, wetlands along the Pecos River, such as those still seen today in the Bitter Lake National Wildlife Refuge and the Bottomless Lakes State Park (both 25–30 km east of the villages), would have offered ideal habitats.

*Intersite comparisons.*—In addition to architectural differences between the Henderson and Rocky Arroyo sites, the avifaunas also differ (Table 1). Some of these differences are due to excavation and recovery biases against smaller bones (and hence against smaller species) at Rocky Arroyo. This bias is apparent in comparing the proportion (based on NISP values) of passerines in the Henderson

TABLE 1.—Avifauna from the Henderson (LA-1549) and Rocky Arroyo (LA-25277) sites, Chaves County, New Mexico, with total number of bones (NISP) and minimum number of individuals (MNI, in parentheses) for each taxon.

| Taxon | LA-1549 | LA-25277 |
|---|---|---|
| Pied-billed Grebe *(Podilymbus podiceps)* | 5 (1) | 1 (1) |
| Double-crested Cormorant *(Phalacrocorax auritus)* | — | 7 (2) |
| Turkey Vulture *(Cathartes aura)***[1] | 1 (1) | 2 (1) |
| Trumpeter Swan *(Cygnus buccinator)** | — | 2 (1) |
| Snow Goose (cf. *Chen caerulescens)** | — | 1 (1) |
| Canada Goose *(Branta canadensis)** | — | 5 (2) |
| Goose (Anserini, indet.) | — | 2 (2) |
| Mallard *(Anas platyrhynchos)** | 1 (1) | 12 (2) |
| Duck *(Anas* sp.) | 1 (1) | 1 (1) |
| Teal *(Anas* sp.) | 6 (2) | 7 (2) |
| Canvasback *(Aythya* cf. *A. valisineria)** | 3 (1) | — |
| Duck *(Aythya* sp.) | — | 2 (1) |
| Scoter *(Melanitta* sp.) | — | 1 (1) |
| Common Goldeneye *(Bucephala clangula)** | — | 3 (1) |
| Common Merganser *(Mergus merganser)** | 2 (1) | — |
| Merganser (cf. *Mergus* sp.) | — | 2 (1) |
| Ruddy Duck *(Oxyura jamaicensis)** | — | 1 (1) |
| Anatidae, indet. | 11 (3) | 2 (1) |
| Bald Eagle *(Haliaeetus leucocephalus)** | — | 2 (1) |
| Northern Harrier *(Circus cyaneus)** | — | 1 (1) |
| Cooper's Hawk *(Accipiter cooperii)* | — | 2 (1) |
| Goshawk *(Accipiter gentilis)** | — | 1 (1) |
| Swainson's Hawk (cf. *Buteo swainsoni)*** | 2 (1) | 2 (1) |
| Red-tailed Hawk *(Buteo jamaicensis)* | 1 (1) | 1 (1) |
| Hawk *(Buteo* sp.) | 14 (2) | 11 (2) |
| Golden Eagle *(Aquila chrysaetos)* | 3 (2) | 1 (1) |
| American Kestrel *(Falco sparverius)* | 2 (1) | — |
| Merlin *(Falco columbarius)* | — | 1 (1) |
| Peregrine Falcon *(Falco* cf. *F. peregrinus)** | — | 3 (1) |
| Prairie Falcon *(Falco* cf. *F. mexicanus)* | — | 1 (1) |
| Turkey *(Meleagris gallopavo)* | 2 (1) | 9 (2) |
| Quail (Odontophorinae, indet.) | 11 (3) | — |
| Scaled Quail *(Callipepla* cf. *C. squamata)* | 2 (2) | — |
| Virginia Rail (cf. *Rallus limicola)* | — | 1 (1) |

TABLE 1. (continued)

| Taxon | LA-1549 | LA-25277 |
|---|---|---|
| Common Moorhen *(Gallinula chloropus)* | 2 (2) | — |
| American Coot *(Fulica americana)* | 60 (9) | 119 (13) |
| Sandhill Crane *(Grus canadensis)** | 3 (1) | — |
| American Bittern *(Botaurus lentiginosis)* | — | 1 (1) |
| Great Egret *(Casmerodius albus)* | 1 (1) | — |
| Dowitcher *(Limnodromus* sp.)** | 1 (1) | — |
| Gull *(Larus* sp.) | — | 1 (1) |
| Mourning Dove *(Zenaida macroura)* | 9 (3) | — |
| Scarlet Macaw *(Ara macao)* | — | 7 (1) |
| Macaw *(Ara* sp.) | — | 1 (1) |
| Screech Owl *(Otus* sp.) | 1 (1) | — |
| Great Horned Owl *(Bubo virginianus)* | 5 (2) | 2 (1) |
| Burrowing Owl *(Athene cunicularia)* | 9 (3) | — |
| Short-eared Owl *(Asio flammeus)** | 1 (1) | — |
| Owl *(Asio* sp.) | 1 (1) | — |
| Northern Flicker *(Colaptes auratus)* | 4 (1) | — |
| Flycatcher *(Tyrannus* sp.) | 1 (1) | — |
| Steller's Jay (cf. *Cyanocitta stelleri)** | — | 1 (1) |
| Chihuahuan Raven *(Corvus cryptoleucus)* | 6 (1) | 4 (2) |
| Crow or Raven *(Corvus* sp.) | — | 2 (1) |
| Northern Cardinal *(Cardinalis cardinalis)* | 1 (1) | — |
| Lark Sparrow *(Chondestes grammacus)*** | 1 (1) | — |
| Sparrow *(Zonotrichia* sp.) | 2 (2) | — |
| Emberizinae, indet. | 1 (1) | — |
| Red-winged Blackbird *(Agelaius phoeniceus)* | 2 (1) | — |
| Meadowlark *(Sturnella* sp.) | 4 (2) | — |
| Brewer's Blackbird *(Euphagus cyanocephalus)** | 1 (1) | — |
| Icterinae, indet. | — | 1 (1) |
| Passeriformes, indet. | 133 | 6 |
| Total | 316 (61) | 232 (59) |

[1]Species that are migratory and found in southern New Mexico during winter months only are indicated by an asterisk (*); spring/summer migrants are indicated by a double asterisk (**) (Hubbard 1978).

sample with their proportion in the sample from Rocky Arroyo (Fig. 6). Passerines are well represented at Henderson, comprising over 48% of the total NISP (152 of 316 bones). In contrast, they constitute barely 6% of the total in the CCAS

sample from Rocky Arroyo (14 of 232 bones), but fully 50.0% of the smaller but systematically recovered sample from Structure 2 (6 of 12 bones), a value nearly identical to the one from Henderson.

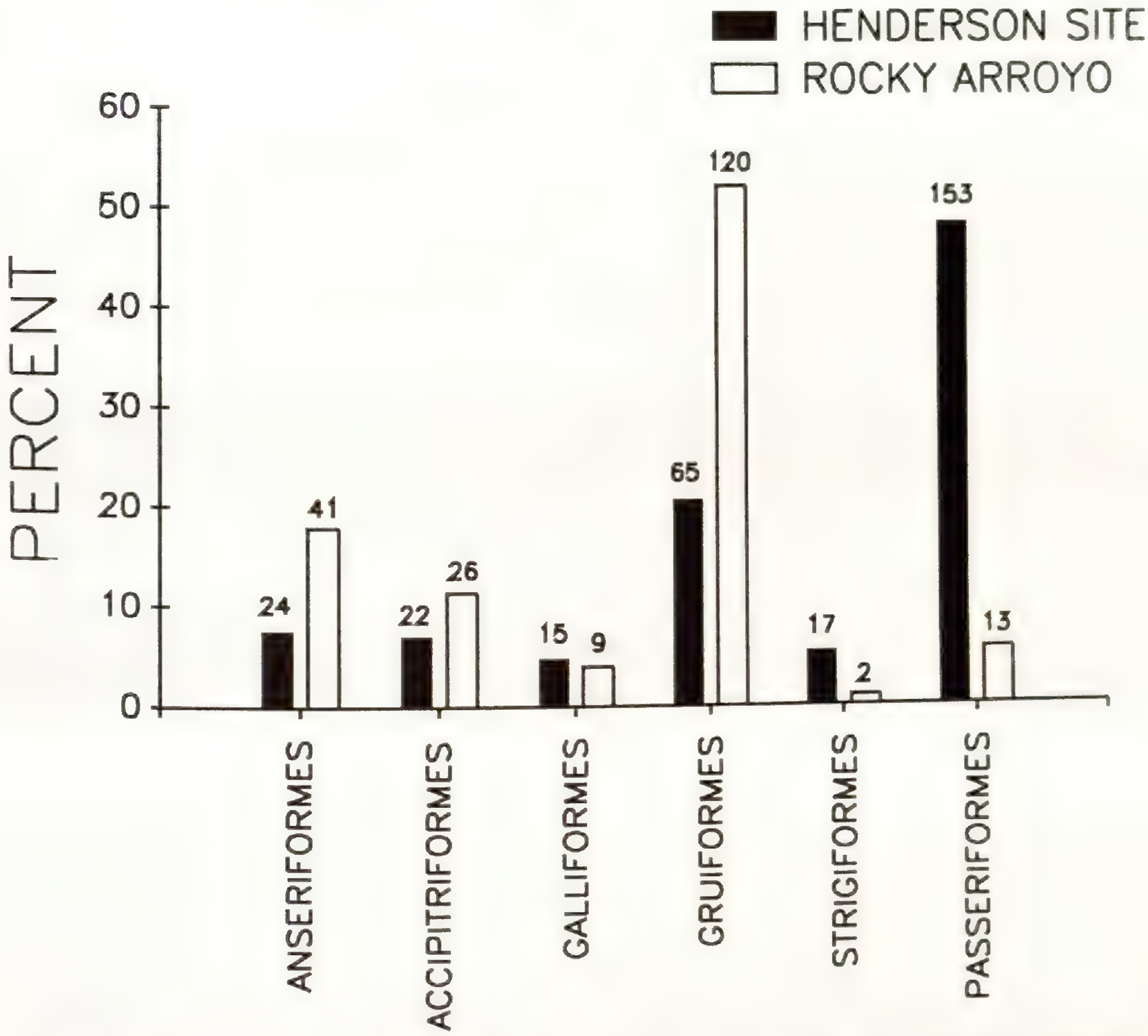


FIG. 6.—Percentage of total NISP (see Table 1) per order of bird bones identified from the Henderson site and Rocky Arroyo site. The number at the top of each bar is the NISP for that order.

It also is possible that some of the differences seen in Table 1 between the Henderson and Rocky Arroyo avifaunas are the result of post-depositional taphonomic processes, particularly differential bone preservation resulting in fewer bones of smaller species at Rocky Arroyo. However, preservation of small and fragile bones was generally excellent at both sites. For example, thousands of tiny, delicate fish bones were recovered at both sites, and many papery fish scales were found in the Structure 2 fill at Rocky Arroyo. Most of the damage on the Rocky Arroyo bones was in the CCAS sample. Not unexpectedly, excavation damage was most apparent on the larger bones, particularly those of bison, on which tool marks and fresh breaks were common. The smaller bones do not show this damage and display few recent breaks. Most bones,

regardless of size, were placed by the excavators in tightly packed tins which protected them from exposure to weathering and decay. While many of the larger bones had become brittle, cracked, and broken, there is little evidence to suggest that bones of any size had disintegrated into unrecognizable debris within the tins.

In sum, it seems reasonable to conclude that differences in the avifaunas between Henderson and Rocky Arroyo, with the exception of the bias against recovery of passerines from lack of screening at the latter site, may have a cultural origin. Thus, the most reliable intersite comparisons will be those that involve the larger-sized bird species, for which screening biases are likely to play a much smaller role.

Statistical comparisons of the percentage NISP per total NISP by orders represented at each site indicate that significantly more bones of Anseriformes and Gruiformes, especially American coot *(Fulica americana)*, were recovered from Rocky Arroyo ($t_S>3.6$, $p<0.001$), and more of Strigiformes and Passeriformes (the latter, as noted above, probably reflecting recovery bias) from Henderson ($t_S>4.9$, $p<0.001$) (Fig. 6). In addition, bones of macaw and cormorant (one with cut-marks) occurred only at Rocky Arroyo, and bones of mourning dove (Columbiformes) were recovered only from the Henderson site. The absence of this last taxon from Rocky Arroyo, however, also may be due to recovery biases of small bones at this site. These comparisons suggest that aquatic birds, including rails, ducks, and geese, were exploited more at Rocky Arroyo than at Henderson. This conclusion is supported by the abundance of other aquatic taxa, including muskrat and a high diversity of fish, at Rocky Arroyo in comparison to Henderson (Wiseman 1985; Rocek and Speth 1986).

*Intrasite comparisons.*—The lack of secure provenience information for most of the avifaunal remains from Rocky Arroyo precludes intrasite comparison of the distribution of bird bones by species or body part. The sample from the Henderson site, however, can be analyzed in this manner with comparisons of bird remains from the room blocks with those from the midden associated with the roasting feature in the east plaza. Sample sizes are too small to permit comparisons among individual rooms.

These comparisons, best expressed in terms of the number of bird bones per cubic meter ($m^3$) of deposit, indicate relatively similar and low bone densities in most of the room blocks and in the east plaza (Table 2). In contrast to these modest values, the trash deposit in room C-5, the only significant midden deposit found in the rooms sampled to date, produced a density of bird bones (11.63/$m^3$) that is nearly 2.5 times greater than the east plaza value. The fill from room C-5 included more than half (53.4%) of the passerine remains recovered from the site, and their density in the trash (8.10/$m^3$; see Table 3) of this room was nearly 7.5 times greater than their density in the east plaza trash (1.09/$m^3$). Differences in densities of bones of other taxa in the rooms compared to the east plaza are based on too few NISP to be reliable.

*Avifaunal exploitation.*—Water birds are important in pueblo symbolism in relation to annual rainfall and the onset of the growing season (Tyler 1979). Conse-

TABLE 2.—Density (number of specimens per cubic meter of deposit) of avian bones by provenience at the Henderson site (all taxa combined).

| Provenience | Total Volume Excavated ($m^3$) | Total Avian NISP | Total Avian Density (bones/$m^3$) |
|---|---|---|---|
| Center Bar | | | |
| All Rooms | 25.76 | 166 | 6.44 |
| Room C–5 only | 8.77 | 102 | 11.63 |
| Excluding Room C–5 | 16.99 | 64 | 3.77 |
| East Bar | 34.85 | 83 | 2.38 |
| East Plaza (Trench C) | 11.90 | 57 | 4.79 |

TABLE 3.—Number of bones (NISP) and density of bones per cubic meter of deposit (in parentheses) for principal taxa (order) by provenience at the Henderson site.

| Order | Center Bar | Room C–5 | East Bar | East Plaza |
|---|---|---|---|---|
| Gruiformes | 34 (1.32) | 1 (0.11) | 29 (0.83) | 11 (0.92) |
| Accipitriformes | 11 (0.43) | 5 (0.57) | 3 (0.09) | 6 (0.50) |
| Galliformes | 11 (0.43) | 7 (0.80) | 0 (0.00) | 2 (0.17) |
| Strigiformes | 5 (0.19) | 6 (0.68) | 2 (0.06) | 4 (0.34) |
| Passeriformes | 108 (4.19) | 71 (8.10) | 40 (1.15) | 13 (1.09) |
| Anseriformes | 11 (0.43) | 6 (0.68) | 5 (0.14) | 5 (0.42) |

quently, duck and goose wing fans are used in ceremonies related to the agricultural cycle. Moreover, certain of these species are migratory and occur only in the winter in southern New Mexico (Table 1). These species were available primarily during late fall through early spring (Hubbard 1978). Bones of fledgling red-tailed hawk, quail, and raven suggest a late spring and summer exploitation of these species.

Many passerine species are also symbols of rain for Southwestern Native Americans; often stuffed birds are included in religious paraphernalia. In this respect, it is interesting that a significantly greater percentage of Passeriformes wing elements compared to leg elements were recovered from the Henderson site (Table 4), perhaps pointing to their particular importance as sources of feathers. Wing bones also outnumber leg bones at Rocky Arroyo, but the numbers are too small for reliable comparisons. Although most of the passerine bones from Henderson could not be identified, those that were include species commonly

TABLE 4.—Comparison of the distribution of wing (radius, ulna, carpometacarpus) and leg (femur, tibiotarsus, tarsometatarsus) elements by order at the Henderson site and Rocky Arroyo.

| | | Henderson site | | Rocky Arroyo | |
|---|---|---|---|---|---|
| Order | | NISP | % | NISP | % |
| Anseriformes: | wing | 5 | 55.6 | 12 | 70.6 |
| | leg | 4 | 44.4 | 5 | 29.4 |
| Accipitriformes: | wing | 8 | 44.4 | 8 | 38.1 |
| | leg | 10 | 55.6 | 13 | 61.9 |
| Galliformes: | wing | 4 | 50.0 | 1 | 12.5 |
| | leg | 4 | 50.0 | 7 | 77.5 |
| Gruiformes: | wing | 13 | 34.2* | 26 | 34.2* |
| | leg | 25 | 65.8 | 50 | 65.8 |
| Passeriformes: | wing | 65 | 63.7* | 6 | 66.7 |
| | leg | 37 | 36.3 | 3 | 33.3 |
| Total Aquatic[1] | wing | 21 | 39.6* | 39 | 39.4* |
| | leg | 32 | 60.4 | 60 | 60.6 |

[1]The category for total aquatic taxa includes bones of Podicipediformes, Pelecaniformes, Ciconiiformes (except Turkey Vulture) and Charadriiformes in the NISP. An asterisk (*) indicates those proportions that are significantly different ($t_s > 2.1$, $p < 0.05$).

associated with agricultural fields, such as icterids, corvids, and sparrows (Emslie 1981a, 1981b, 1983).

While wing elements outnumber leg elements in passerines, this is not so in the other orders that are represented at the sites (Table 4). In the aquatic birds, especially Gruiformes, leg elements significantly outnumber wing elements. While this in no way precludes the use of aquatic bird feathers for ritual, fletching arrows, or other purposes, the abundance of leg elements suggests that these birds were used for food since the legs contain greater muscle mass than the wings. However, only five bird bones (less than 1%) from the two sites were burned, and most or all of these derive from species that were probably of little or no importance as sources of food: a humerus and an ulna of unidentified passerines from Henderson, and two *Corvus* sp. tibiotarsi and a tarsometatarsus of *Falco columbarius* from Rocky Arroyo. Moreover, none of the bones of aquatic species were burned.

If birds were being eaten in any quantity at Henderson and Rocky Arroyo, the scarcity of burned elements suggests that roasting was not a common method of preparation. This contrasts to bison: about 6% of the bison bones are burned. Interestingly, turkey *(Meleagris gallopavo)*, probably an important source for food as well as feathers in the late prehistoric Southwest, is rare at both sites; only two bones were recovered from Henderson and nine from Rocky Arroyo. The apparent scarcity or absence of captive or domestic turkeys at the Henderson site,

a comparatively large village, is intriguing. A few unidentifiable shell fragments from eggs large enough to be turkey were recovered at Henderson. If these fragments do derive from turkey eggs, they might provide indirect evidence for the presence of captive or domestic birds in the village. However, they could easily have been taken from wild birds.

The large number of passerines at Henderson, as well as coots and other aquatic birds at both sites, suggests specialization in the use of avian resources by the occupants of these sites. Avifaunal specialization by Pueblo Indians is not unknown in the prehistoric Southwest. Over 2,000 bones of turkey *(Meleagris gallopavo)* from Sapawe Pueblo (A.D. 1400–1550) and Pottery Mound (A.D. 1325–1490; 88.4% and 64.0% of total avian NISP from these sites, respectively), and hundreds of bones of golden eagle from Picuris Pueblo (A.D. 1250–present; 34.4% of NISP) and sandhill crane from Pottery Mound (10.0% of NISP), indicate large-scale exploitation of these taxa specific to those pueblos (Emslie 1981a). At Rocky Arroyo and Henderson, the large number of coot bones is unusual. This species was poorly represented (<1% of total avian NISP) in the large samples of bone from Pottery Mound, Picuris, and Sapawe (Emslie 1981a). We speculate that coot may have had an important symbolic function at Rocky Arroyo and Henderson, similar to that of other aquatic species.

Site-specific avifaunal specialization in the Southwest may have been encouraged by the development of trade centers for distributing feather blankets, food, and whole birds or feathers for ceremonial use in puebloan religion. The symbolic role of birds is apparent from preserved kiva murals at Kuaua and Pottery Mound (Dutton 1963; Hibben 1975), and through ethnographic studies (Tyler 1979). Specialization also may have developed in relation with particular clans and/or kinship groups that occupied specific pueblos (Emslie 1981a). Based on the avifaunal data from Henderson and Rocky Arroyo, it is possible that these communities were gathering coots and passerines for local or regional exchange.

*Prehistoric trade of birds.*—The scarlet macaw bones at Rocky Arroyo indicate trade with Mesoamerica. At least one individual is represented by eight bones; included are elements of the skull, wings, and legs. The remains may have been part a single macaw burial, or one or more individuals from diverse proveniences. In addition to the macaw at Rocky Arroyo, seven copper bells (another trade item from Mesoamerica) were recovered from Bloom Mound, a roughly contemporaneous pueblo located within 2 km of Henderson (Kelley 1984).

Macaw bones and feathers are known from prehistoric sites throughout the Southwest as far north as southeastern Utah (Hargrave 1979). The bones from Rocky Arroyo represent the easternmost occurrence of this species in the prehistoric Southwest. In addition, if the age of this site is correct (1250/1275–1325), these bones represent one of the latest records of macaw trade prior to Spanish contact. Trade with Mesoamerica appears to have ceased in the 1300s (Kelley and Kelley 1975). This breakdown is supported by negative evidence at Pottery Mound, a pueblo established about A.D. 1325, or approximately when Rocky Arroyo was abandoned (though the age of this site may be more correctly placed at post–A.D. 1400, E. Charles Adams, personal communication to Speth, 1991).

This large pueblo produced thousands of bird bones, but none of macaw despite its frequent representation in the many kiva murals preserved there (Hibben 1975). A revival of macaw trade may have occurred in the 1400s (Hargrave 1970). Apparently, Rocky Arroyo represents one of the latest pueblo sites in the Southwest to be involved with trade from Mesoamerica before the breakdown.

Another possible trade item with Mesoamerica is the northern cardinal. This species was rare in Arizona and apparently absent in New Mexico prior to the 1870s, but expanded its range northward and eastward in the following decades (Phillips 1968). It did not become established in New Mexico until the early part of this century. We know of no other archaeological records of cardinal in New Mexico, though there are three records from Arizona with the earliest dating from A.D. 850–950 (Ferg and Rea 1983). These authors suggest that cardinals, because of their bright plumage similar to macaws, may have been brought into the American Southwest from Mesoamerica through trade. This suggestion assumes that the species only recently expanded its range northward, and did not formerly occur in the Southwest where it may have disappeared for unknown reasons prior to historic times. Until this problem is resolved, it is possible that the specimen from Rocky Arroyo represents an additional trade item at this site.

## CONCLUSIONS

Excavations of the Rocky Arroyo and Henderson sites have provided diverse avifaunas that are the first of their age to be reported in detail from southeastern New Mexico. The presence of the scarlet macaw *(Ara macao)* at Rocky Arroyo is the easternmost record of this species in the prehistoric Southwest and, in conjunction with the copper bells from nearby Bloom Mound, and possibly also the cardinal from Henderson, indicates thirteenth and/or fourteenth century trade links between the Pecos Valley and regions to the west and south. Moreover, we believe these sites present additional evidence that specialized exploitation of avian resources, perhaps for trade, was occurring in the late prehistoric Southwest. ,This specialization probably developed in conjunction with an agricultural economy; many species of birds are highly symbolic among modern Pueblo Indians, especially in relation to the growing season.

The preponderance of aquatic species at Rocky Arroyo may reflect specialization at this site for birds that were used for food and religious/ceremonial purposes. A similar specialization in aquatic species was not apparent at the Henderson site, though it is located on the same drainage and is roughly contemporaneous with Rocky Arroyo. Henderson occupants may have specialized on the acquisition of passerines instead of waterfowl, but excavation biases may have caused an unbalanced recovery of these small birds from these sites.

## NOTES

[1]It should be pointed out that the name Rocky Arroyo also has been used for a late Pleistocene cave fauna and archaeological site from which fossil bird bones were reported by Wetmore (1931, 1932). However, this cave is located in Eddy County, northwest of Carlsbad, New Mexico, and is not the same Rocky Arroyo as discussed here.

[2]Proveniences associated with lot numbers 1–2027 have been published in Rocek and Speth (1986:300–342); proveniences for higher lot numbers, most of which denote specimens from flotation samples, have not been published but are available from JDS.

[3]All Rocky Arroyo specimens are deposited at the Laboratory of Anthropology of the Museum of New Mexico in Santa Fe; the Henderson materials are currently on long-term loan from the former land-owners of the site to the Museum of Anthropology of the University of Michigan in Ann Arbor. The final repository for these specimens has not yet been determined. The Henderson site has since been donated to The Archaeological Conservancy.

## ACKNOWLEDGEMENTS

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## APPENDIX: REFERRED MATERIAL

| Taxon | Element[1] | Description |
|---|---|---|
| Podicipediformes<br>Podicipedidae<br>*Podilymbus podiceps*<br>(Linnaeus, 1758) | LA-1549: DL humerus, 1262; L ulna, Fea. 25; R carpometacarpus, 1123; DR femur, 1586; PL tibiotarsus, 2055<br>LA-25277: R ulna, Loc. 2 | |
| Pelecaniformes<br>Phalacrocoracidae<br>*Phalacrocorax auritus*<br>(Lesson, 1831) | LA-25277: PR humerus, Loc. 1; DR humerus, R femur, PR and PL tarsometatarsi, Loc. 1-2; PL humerus, Loc. 2; DL tarsometatarsus, Loc. 4 | D humerus from Loc. 1-2 has small, oblique cut-marks on D external shaft. |
| Ciconiiformes<br>Vulturidae<br>*Cathartes aura*<br>(Linnaeus, 1758) | LA-1549: DL ulna, 941<br>LA-25277: partial pelvis, Loc. 2; DR radius, Loc. 4 | |
| Anseriformes<br>Anatidae<br>*Cygnus buccinator*<br>Richardson, 1832 | LA-25277: DL ulna, PR femur, Loc. 1-2 | Specimens are distinguished from *C. columbianus* by their larger size and osteological characters. D ulna cut from shaft by groove and snap technique (Olsen 1979) |
| cf. *Chen caerulescens*<br>(Linnaeus, 1758) | LA-25277: PR humerus, Loc. 2 | |
| *Branta canadensis*<br>(Linnaeus, 1758) | LA-25277: humeral end R coracoid, L scapula, Loc. 1-2; DL humerus, L carpometacarpus, wing phalanx, Loc. 2 Lot 1001. | Humerus measurements: D breadth and depth, 28.0, 16.8 mm. Carpometacarpus: length, 105.2 mm; P breadth and depth, 11.0, 28.3 mm; D breadth and depth, 11.6, 12.6 mm. |

APPENDIX: REFERRED MATERIAL (continued)

| Taxon | Element[1] | Description |
|---|---|---|
| | | Specimens fall within size range of *B. canadensis canadensis,* the most common subspecies in New Mexico. Element is too variable for generic recognition. |
| Anserini, indet. | LA-25277: 2 manubria of sternum, Loc. 2 and 3. | |
| *Anas platyrhynchos* Linnaeus, 1758 | LA-1549: L ulna missing P end, 1331.<br>LA-25277: 2 L scapulae, L coracoid, PL ulna, DR radius, DR humerus, Loc. 1-2, L coracoid, 2 PL humeri, R tarso-metatarsus, Loc. 2; DL humerus, L carpometacarpus missing P end, Loc.3. | |
| *Anas* sp. | LA-1549: L coracoid, 540; R coracoid, 799; L ulna, 851; L radius, 1207; PL humerus, 791; 2 DL humeri, 1233 and 1452.<br>LA-25277: furculum, R radius, L ulna, L ulna missing D end, 2 R humeri missing P ends, Loc. 1-2; L humerus missing P end, DL carpo-metacarpus, Loc. 2. | All bones, except L coracoid (540) and one R humerus from LA-25277, are from a teal-sized duck similar to *A. crecca* or *A. discors.* The two remaining bones are from a duck near the size of *A. acuta* or *A. clypeata* but are too fragmentary for specific identification. |
| *Aythya* cf. *A. valisineria* (Wilson, 1814) | LA-1549: L coracoid and humerus, 684; PL scapula, 1108. | |
| *Aythya* sp. | LA-25277: manubrium of sternum, DR ulna, Loc. 1-2. | |

| | | |
|---|---|---|
| *Melanitta* sp. | LA-25277: PL carpometacarpus, Loc. 1-2 | |
| *Bucephala clangula* (Linnaeus, 1758) | LA-25277: DR humerus, R femur, Loc. 1-2; manubrium of sternum, Loc. 2. | |
| *Mergus merganser* Linnaeus, 1758 | LA-1549: humeral end R coracoid, 794; PL humerus, 1384. | |
| cf. *Mergus* sp. | LA-25277: DR carpometacarpus, Loc. 2; PR tibiotarsus, Loc. 1-2. | |
| *Oxyura jamaicensis* (Gmelin, 1789) | LA-25277: R humerus missing P end, Loc. 3. | |
| Anatidae, indet. | LA-1549: R scapula, 2008; 3 MR coracoids, 291, 1059, 513N531E 101.90-101.85; sternal end R coracoid, 1259; DR ulna, 525N565E 101.40-101.30; DR carpometacarpus, 1340; DR tibiotarsus 853; ML tarsometatarsus, 291; PL tarsometatarsus, 1218; DR tarsometatarsus, 1010. | |
| | LA-25277: D symphysis of mandible, Loc. 2 Lot 101; PR tibiotarsus, Loc. 3. | |
| Accipitriformes | LA-25277: PR humerus, Loc. 1; L femur, Loc. 2. | Humerus has striations parallel to shaft on the palmar side, possibly caused by cutting the wing from the shoulder girdle. |
| Accipitridae | | |
| *Haliaeetus leucocephalus* (Linnaeus, 1766) | | |
| *Circus cyaneus* (Linnaeus, 1766) | LA-25277: DL humerus, Loc. 2 | |
| *Accipiter cooperii* (Bonaparte, 1828) | LA-25277: DL carpometacarpus, Loc. 1-2; R femur, Loc. 2. | |
| *A. gentilis* (Linnaeus, 1758) | LA-25277: PR carpometacarpus, Loc. 1-2. | |

APPENDIX: REFERRED MATERIAL (continued)

| Taxon | Element[1] | Description |
|---|---|---|
| *Buteo* cf. *B. swainsoni* Bonaparte, 1838 | LA-1549: DL ulna, 521; DL tarsometatarsus, 1232.<br>LA-25277: PR femur, DR tibiotarsus, Loc. 2. | |
| *B. jamaicensis* (Gmelin, 1788) | LA-1549: rostrum, 509N549E 99.80-99.70.<br>LA-25277: R tibiotarsus, Loc. 1 | |
| *Buteo* sp. | LA-1549: R coracoid, 1336; DL radius, 286; R radius, 935; PR ulna, 521; DL humerus, 1452; PL carpometacarpus, 1283; PL femur, 1500; DL femur, 513N533E (surf.); PR femur, 1325; L tibiotarsus 513N533E (surf.); PL tibiotarsus, 39; 3 DL tarsometatarsi, 272, 641, 1259.<br>LA-25277: PR ulna, ML humerus, Loc. 1; DL ulna, PR humerus, DR femur, MR tibiotarsus, Loc. 1-2; 2 PR ulnae, 2 PR femora, Loc. 2; PL tarsometatarsus, Loc. 3. | All specimens from hawk similar in size to *B. jamaicensis*. D humerus (1452) is porous, probably from fledgling. |
| *Aquila chrysaetos* (Linnaeus, 1758) | LA-1549: PR scapula, 997; DL ulnae, 394, 805.<br>LA-25277: PL carpometacarpus, Loc. 2. | |
| Falconidae<br>*Falco sparverius* Linnaeus, 1758 | LA-1549: PL ulna, 855; DR tarsometatarsus, 270. | |

| | | |
|---|---|---|
| *F. columbarius* Linnaeus, 1758<br>cf. *F. peregrinus* Tunstall, 1771<br>cf. *F. mexicanus* Schlegel, 1851 | LA: 25277: DL tarsometatarsus, Loc. 2.<br><br>LA-25277: DL humerus, Loc. 1; DR ulna, Loc. 1-2; R femur, Loc. 4.<br>LA-25277: DL humerus, Loc. 2 | Burned. |
| Galliformes<br>Phasianidae<br>*Meleagris gallopavo* Linnaeus, 1758 | LA-1549: PR carpometacarpus, 828; DL tibiotarsus, 1547.<br>LA-25277: PR radius, DL femur, DL tibiotarsus, Loc. 1; PR scapula, DL femur, PR femur, L tarsometatarsus missing D end, Loc. 1-2; PL femur, PR tarsometatarsus, Loc. 3. | McKusick (1986) recognizes two breeds of domestic turkey from the prehistoric Southwest: large Indian domestic and small Indian domestic. Her criteria for distinguishing these breeds depend on comparative lengths of complete elements. No complete elements were present in this sample. |
| Odontophorinae, indet. | LA-1549; L coracoid, 1737; humeral end R coracoid, 148; R ulna, 1999; PR ulna, 1173; ML humerus, 32; DL humerus, 1422; L humerus missing D end, 291; R carpometacarpus, 94; DL femur, 1563; DR tibiotarsus, 924; L tarsometatarsus, 1906. | L humerus (291) is incompletely ossified and from a juvenile. Specimens were compared to *Cyrtonyx montezumae, Oreortyx pictus, Colinus virginianus, Callipepla squamata* and *C. gambelii,* and most closely resemble *Colinus* or *Callipepla* in size and characters, but are too fragmentary for positive identification. |
| *Callipepla* cf. *C. squamata* (Vigors, 1830) | LA-1549: 2 PR humeri, 536, 826 | Specimens are referred to this species based on the larger breadth of the fossa below the P head, anconal surface, in *C. squamata* com- |

| Taxon | Element[1] | Description |
|---|---|---|
| | | pared to *C. gambelii* and *Colinus virginianus*. |
| Gruiformes | | |
| Rallidae | | |
| cf. *Rallus limicola* Vieillot, 1819 | LA-25277: R tarsometatarsus, Loc. 2. | |
| *Gallinula chloropus* (Linnaeus, 1758) | LA-1549: R ulna, 1571; PR ulna, 1353. | |
| *Fulica americana* Gmelin, 1789 | LA-1549: mandible, 921; 2 manubria of sternum, 928, 1357; PL scapula, 1897; PR scapula, 635; 3 L coracoids, 840, 1092, 1153; 4 humeral ends L coracoids, 143, 157, 535, 1374; 2 L coracoids missing humeral ends, 540, 1416; 3 R coracoids, 108, 288, 2003; 2 R coracoids missing humeral ends, 271, 1525; 1 P and 4 DR humeri, 1216, 513N528E (surf.), 221, 224, 1209; 3 DL humeri, 1 (surf.), 1071, 1274; R ulna, 1511; MR ulna, 1507; DR ulna, 510; 1 P and 1 DL carpometacarpus, 7, 1274; 2 R carpometacarpi, 973, 514N531E 101.45-101.35; 1 P and 1 DR carpometacarpus, 1580, 1150; L femur, 1569; 1 P and 2 DL femora, 1512, 1271, 1390; L tibiotarsus, 314; ML tibiotarsus, 1143; 4 DL tibiotarsi, 90, 520, 1038, 1446; MR tibiotarsus, 886; 6 DR tibiotarsi, 152, 358, 770, 794, 846, 984; L tarsometatarsus missing D end, 1 (surf.); 2 L tarsome- | |

tatarsi missing P ends, 799, 1414; 2 DL and 1 R tarsometatarsi, 78, 1025, 1575; PR tarsometatarsus, 770.

LA-25277: 4 L and 4 R femora, 1 DR femur, Loc. 1; 4 L and 1 R scapulae, 3 L and 4 R coracoids, 3 L humeri, 5 L and 4 R humeri missing P ends, 1 P, D, and MR humeri, 1 PL radius, 6 L and 3 R ulnae, 1 PL and R ulnae, 2 DR ulnae, 1 R carpometacarpus, 1 partial pelvis, 2 R tibiotarsi, 2 P and and 10 DL tibiotarsi, 2 L and 1 R tibiotarsi missing P end, 3 D and 3 PR tibiotarsi, 1 L and 1 R tarsometatarsus, 2 ML tarsometatarsi, 2 R tarsometatarsi missing D ends, Loc. 1-2; 1 rostrum and lower mandible, sternum, 5 manubria of sternum, sternal half R coracoid, PR scapula, 1 DL and PR humeri, 4 L and 4 R carpometacarpi, 1 PL and 1 DR carpometacarpi, 1 partial pelvis, 1 DR femur, 1 DL and PR tibiotarsus, 1 R tibiotarsus missing P end, 1 R tarsometatarsus, 1 L tarsometatarsus missing P end, 1 DR tarsometatarsus, Loc. 2; L humerus, PL humerus, R carpometacarpus, 2 R femora, L tarsometatarsus missing P end, Loc. 3; R coracoid missing humeral end, L tarsometatarsus, Loc. 4

APPENDIX: REFERRED MATERIAL (continued)

| Taxon | Element[1] | Description |
|---|---|---|
| Gruidae<br>*Grus canadensis*<br>(Linnaeus, 1758) | LA-1549: DL ulna, 1209; PR ulna, 1209; DL femur, 1287. | D femur (1287) cut from shaft by the groove and snap technique. |
| Ardeiformes<br>Ardeidae<br>*Botaurus lentiginosus*<br>(Rackett, 1813) | LA-25277: PL tibiotarsus, Loc. 1-2. | |
| *Casmerodius ablus*<br>(Linnaeus, 1758) | LA-1549: DR femur, 1586. | |
| Charadriiformes<br>Scolopacidae<br>*Limnodromus* sp. | LA-1549: PR carpometacarpus, 350. | |
| Laridae<br>*Larus* sp. | LA-25277: L coracoid, Loc. 1-2. | Specimen compared to *L. argentatus, L. glaucescens, L. hyperboreus,* and *L. occidentalis,* which are all larger and more robust, and *L. atricilla, L. canus,* and *L. philadelphia,* which are smaller. *L. californianus* has robust shaft and larger fossa below the brachial tuberosity; *L. delawarensis* has narrower furcular facet. Specimen is most similar to *L. heermanni* in size and proportions, but additional material is needed for positive identification. |

| | | |
|---|---|---|
| Columbiformes<br>Columbidae<br>*Zenaida macroura*<br>(Linnaeus, 1758) | LA-1549: L coracoid, 532; R radius, 830; R ulna, 188; PR humerus, 1125; ML carpometacarpus, 2283; 3 R carpometacarpi, 95, 839, 1590; R femur, 1794. | |
| Psittaciformes<br>Psittacidae<br>*Ara macao* (Linnaeus, 1758) | LA-25277: PR humerus, Loc. 1; rostrum, R coracoid, L coracoid, R carpometacarpus, PR tibiotarsus, Loc. 1-2; L femur, Loc. 3 | Specimens compared to skeletons (n>3) of *A. macao* and *A. militaris;* osteological characters that distinguish *A. macao* include rostrum with line of culmen broad and well rounded (narrow in *A. militaris),* and absence of angle in bicipital crest where it meets shaft of humerus (angle present in *A. militaris;* Hargrave 1970). |
| *Ara* sp. | LA-25277: DR ulna, Loc. 1. | |
| Strigiformes<br>Strigidae | | |
| *Otus* sp. (Linnaeus, 1758) | LA-1549: DR humerus, 1615. | |
| *Bubo virginianus*<br>(Gmelin, 1788) | LA-1549: L coracoid, 1883; R coracoid, 1 (surf.); ML humerus, 839; DL humerus, 1055; L tarsometatarsus, 168.<br>LA-25277: R tarsometatarsus, Loc. 1; PR humerus, Loc. 2. | P end of L humerus (839) removed using the groove and snap technique. L tarsometatarsus (168) has 5-6 deep cuts perpendicular to P external shaft. |
| *Athene cunicularia*<br>(Molina, 1782) | LA-1549: mandible, 839; L coracoid, | Tarsometatarsus (1551) is porous, |

APPENDIX: REFERRED MATERIAL (continued)

| Taxon | Element[1] | Description |
|---|---|---|
| | 1165; 2 R coracoids, 858, 1993; L humerus, 971; DR tibiotarsus, 905; R tarsometatarsus, 1551; 2 DR tarsometatarsi, 905, 1507. | probably from a fledgling. |
| *Asio flammeus* (Pontoppidan, 1763) | LA-1549: rostrum, 1915. | |
| *Asio* sp. | LA-1549: fragmentary mandible. | |
| Piciformes | | |
| Picidae | | |
| *Colaptes auratus* (Linnaeus, 1758) | LA-1549: PR humerus, 855; L and R carpometacarpus, 1349, 1220; PR tibiotarsus, 801. | |
| Passeriformes | | |
| Tyrannidae | | |
| *Tyrannus* sp. | LA-1549: partial mandible lacking P ends, 1994. | |
| Corvidae | | |
| cf. *Cyanocitta stelleri* (Gmelin, 1788) | LA-25277: DL tibiotarsus, Loc. 2. | |
| *Corvus cryptoleucus* Couch, 1854 | LA-1549: sternal ends L and R coracoid, 751, 266; PR humerus, 1390; R femur missing P end, 405; 1 DL and R tibiotarsi, 1452, 851. | L humerus from LA-25277 (Loc. 1-2) is porous, probably from a fledgling. |

| | | |
|---|---|---|
| | LA-25277: L coracoid missing humeral end, L humerus missing P end, Loc. 1-2; D and PR ulnae, Loc. 2. | |
| *Corvus* sp. | LA-25277: ML tibiotarsus, DR tibiotarsus, Loc. 2. | Both burned. |
| Emberizidae | | |
| *Cardinalis cardinalis* (Linnaeus, 1758) | LA-1549: partial mandible, 2172. | |
| *Chondestes grammacus* (Say, 1823) | LA-1549: partial rostrum, 1325. | |
| *Zonotrichia* sp. | LA-1549: 2 mandibles, 60, 971. | |
| Emberizinae, indet. | LA-1549: rostrum, 851. | |
| *Agelaius phoeniceus* (Linnaeus, 1766) | LA-1549: rostrum, 639; mandible, 639. | |
| *Sturnella* sp. | LA-1549: rostrum, 1078; L and R mandibles, 1330, 1207; D portion of mandible, 2256. | |
| *Euphagus cyanocephalus* (Wagler, 1829) | LA-1549: rostrum, 1166. | |
| Icterinae, indet. | LA-25277: L humerus, Loc. 1.2. | |
| Passeriformes | | |
| Fam. et Gen. indet. | LA-1549: sternum, 639; 2 manubria of sternum, 1472, 1942; 7 L coracoids, 639, 1247, 1341, 1356, 1858, 1983, 2144; 5 R coracoids, 21, 258, 639, 969, 1190; DL scapula, 1 (surf.); 6 L humeri, 283, 639, 720, 1235, 1613, 1970; 3 R humeri, 639, 1010, 1237; 2 PL humeri, 1726, 2282; 3 PR humeri, 382, 1467, 1472; R humerus missing | L humerus (1613) and PR ulna (855) from LA-1549 burned. Shaft of DR tarsometatarsus (1425), also from LA-1549, cut. |

APPENDIX: REFERRED MATERIAL (continued)

| Taxon | Element[1] | Description |
|---|---|---|
| | | both ends, 148; 2 DL humeri, 1379, 2021; DR humerus, 2100; L radius, 639; R radius, 639; 16 L ulnae, 349, 829, 839, 851, 851, 909, 956, 984, 1094, 1153, 1207, 1207, 1551, 1562, 1966, 1966; 15 R ulnae, 1 (surf.), 639, 830, 851, 872, 897, 1153, 1189, 1189, 1207, 1397, 1452, 1479, 1553, 528N565E 100.80-100.70; 2 PL ulnae, 851, 2178; 4 PR ulnae, 855, 1703, 2144, 525N566E 100.70-100.65; 2 DL ulnae, 486, 842; 4 DR ulnae, 1 (surf.), 291, 2019, 2254; 12 L carpometacarpi, 188, 639, 835, 840, 858, 872, 908, 1543, 1787, 2214, 2219, 528N566E 100.90-100.80; 6 R carpometacarpi, 243, 639, 830, 1994, 2043, 528N566E 100.90-100.80; PL carpometacarpus, 944; PR carpometacarpus, 1780; 2 L femora, 639, 1654; 3 R femora, 1 (surf.), 639, 513N535E 101.15-101.05; 2 L tibiotarsi, 639, 1452; R tibiotarsus, 639; 2 PR tibiotarsi, 1988, 525N566E 100.80-100.70; PL tibiotarsus, 1654; DR tibiotarsus, 1180; 3 DL tibiotarsi, 168, 2125, 525N566E 100.95-100.90; 3 L tarsometa- |

tarsi, 639, 2075, 2158; 5 R tarsometatarsi, 1981, 2140, 1194, 1966, 2253; 3 PL tarsometatarsi, 2129, 2144, 2146; 3 PR tarsometatarsi, 639, 1385, 2037, DL tarsometatarsus, 1969; 4 DR tarsometatarsi, 102, 639, 1168, 1425.

LA-25277: R coracoid, L and R ulna, P and DR ulna, Loc. 2.

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[1]D = distal; P = proximal; M = medial; R = right; L = left

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# FOOD TABOOS AT BUZIOS ISLAND (BRAZIL): THEIR SIGNIFICANCE AND RELATION TO FOLK MEDICINE

ALPINA BEGOSSI
*Núcleo de Estudos e Pesquisas Ambientais*
*Universidade Estadual de Campinas, CP 1170*
*Campinas, 13081, SP, Brazil*

ABSTRACT.—Búzios Island is a fishing community of about 44 families located off the coast of São Paulo State, Brazil. This study focuses on the food taboos of the islanders from Búzios, specifically on prohibitions in the consumption of certain species of fish and lizard. Interviews and observations on food habits were made from November 1986 to December 1987. Some fish are avoided only when persons are ill and others are recommended for these cases. Among the generally avoided fish, moray and ray receive special attention. The reasons for these avoidances were investigated and it was observed that carnivorous fish, more than other fish, are avoided during illnesses. The toxicity of fishes might also explain some avoidances. Finally, medicinal uses of some species, such as rays and lizards, seem to explain some important dietary taboos: medicinal animals may be saved as a source of drugs.

RESUMO.—A Ilha dos Búzios, situada no litoral do Estado de São Paulo, é povoada por uma comunidade de pescadores com aproximadamente 44 familias. O objetivo deste estudo é entender as proibições (tabus) alimentares dos habitantes de Búzios, especialmente aqueles referentes ao consumo de certos peixes e do lagarto. Entrevistas e observações sobre hábitos alimentares foram realizadas de novembro de 1986 a dezembro de 1987. Alguns peixes são evitados, enquanto outros são recomendados em caso de doenças. Dentre os peixes evitados no consumo alimentar merecem atenção a moreia e a raia. As razões dessas proibições alimentares são analisadas. Peixes carnivoros em geral são evitados por doentes. Peixes tóxicos podem explicar outros tabus. Finalmente, o uso medicinal de alguns animais, como da raia e do lagarto, parece explicar alguns tabus alimentares importantes. Animais usados na medicina caseira podem estar sendo preservados como fonte de remédios.

RESUME.—L'ile de Búzios, située au litoral de São Paulo, est peuplée par une communité de pêcheurs, approximativement 44 familles. L'objectif de cette étude est de comprendre les prohibitions (''taboos'') alimentaires des habitants de Búzios, en particulier celles qui se rapportent à la consomation de certains poissons et du lézard. Des entrevues et des observations sur les habitudes alimentaires ont été realisées de novembre 1986 à décembre 1987. Certains poissons sont évités et d'autres sont indiqués en cas de maladie. Parmi les poissons évités, dans la consomation alimentaire, meritent attention la murène et la raie. Les motifs de ces prohibitions alimentaires sont analisés. Les poissons carnivores sont, en général, évités par les malades. Les poissons toxiques peuvent expliquer d'autres prohibitions. Finalement, l'usage medicinal de certains animaux, comme la raie et le lézard, semble expliquer certaines prohibitions alimentaires. Les animaux utilisés dans la medicine ménagère pourraient être épargnés, entant que source de medicine.

## INTRODUCTION

Food taboos and preferences have been an area of debate in ecological-cultural studies between materialists/utilitarians and symbolists/structuralists. Vayda (1987) reviewed part of this debate through the analysis of Harris's (1985) cultural materialist position.

The objectives of this study are to analyze possible ecological reasons related to the main animal avoidances reported and observed at Búzios Island, and to verify the relationships of the patterns of avoidances to protection of medicinal animals.

There are different questions concerning food taboos and the schools of thought mentioned above reflect these approaches. Symbolists have studied the relationship of taboos to religion and rituals and have focused on their *emic* aspects. For example, Barthes (1961) analyzed the psycho-sociological aspects of certain contemporary American and French feeding habits. Douglas (1969), in the classical study "Abominations of Leviticus," concluded that dietary laws were liturgical signs of purity. Sahlins (1976), stressing the importance of "cultural reason" to explain human food habits, states that edibility is inversely related to "humanity." For example, American avoidances of horse and dog are explained because they participate as subjects (and not objects) in American society. Dogs and horses are named and people commonly converse with them. On the other hand, this behavior does not occur with edible animals, such as pig and cattle. Another emic approach was taken by Basso (1972) in her study of food classification and linguistic categories among the Kalapalo Indians of the Upper Xingu (Brazil).

The questions which interest materialists are essentially related to environmental aspects of the issue and represent an *etic* approach to dietary practices. As Ross (1978) stresses, the comprehension of indigenous ideologies may be at least partially explained by material circumstances. For example, Harris (1977, 1985, 1987a, 1987b) attempts to analyze the costs and benefits involved in the adoption and spread of particular behaviors in human populations, such as food taboos and preferences. Harris's analysis of the taboo of the sacred cow of India indicated that cows were too important to be eliminated. They were animals that drew plows upon which agriculture depended. Indian farmers who slaughtered their cattle could never plow again (Harris 1977, 1985).

Other studies have included both emic and etic analyses, such as Ferro-Luzzi's (1975) study on the positive and negative attitudes towards food among Indian tribes. Others have analyzed the effects that food taboos may have on resources, such as the studies by McDonald (1977) and by Reichel-Dolmatoff (1976). The important point, as mentioned by Basso (1978), is that these different perspectives on food taboos and preferences are not incompatible but complementary.

The approach taken in this study is both etic and emic. The strong etic basis is reflected in reference to aspects of the environment, such as fish diet, fish toxicity, and medicinal use, that might explain some food taboos. Emic aspects include the perceptions islanders have about fish, such as their behavior or smell. The aim of this study is the search for possible environmental reasons that could be behind the food taboos observed at Búzios Island.

There are few studies on food taboos of Brazilian maritime communities. However, Amazonian food taboos have been widely discussed and reviewed, in particular by Ross (1978). He stressed that Amazon food prohibitions can be explained by the costs and benefits of resource procurement strategies. Most data on Amazon food taboos concern game animals (Ayres and Ayres 1979; Chagnon and Hames 1980; Kiltie 1980; Moran 1977; Smith 1976). Food taboos related to game and fish species are reported by Basso (1972, 1973), Moran (1974), and Pereira (1974).

There are few studies which report on specific fish or groups of fish considered tabooed foods in the Amazon. Goulding (1981) observed that although electric fishes (gymnotoids) are the third most abundant group in the Amazon, they have no importance in the fisheries because most are small and stay hidden, and there are cultural taboos against eating them. Smith (1981) pointed out that certain fish species are avoided by Camayurá and Tapirapé Indians, as well as other Amazon inhabitants. Among Indians from the Upper Xingu, fish avoidances related to the physical state of a person and to the diet of fish were observed (Basso 1972). Recently, Begossi and Braga (1992) analyzed the relationship of food taboos and fish diet on the Tocantins River.

## THE COMMUNITY

Búzios Island is a fishing community of about 220 individuals (44 families) located on the coast of São Paulo State (Fig. 1). The population of Búzios is distributed among eight small harbors, each of which has a dock and canoe shelters. The most populated harbor is Porto do Meio which included 23 families at the time of fieldwork.

Islanders from Búzios, as is the case for other inhabitants of the relatively isolated areas of southeast coastal Brazil, are called *caiçaras*. They are descendents of Tupinambás Indians and Portuguese. Fishing and manioc cultivation are their main activities (Ribeiro 1987). Indian influences are noticed especially in the processing of manioc flour. Portuguese influences are found in the fishing technology, such as nets and longlines (Mussolini 1980). In Brazil, slavery existed until the end of the nineteenth century and African features are found in the religious and in magical beliefs of the *caiçaras,* such as in the festival of São Benedito, a black saint (Correa 1981). In the beginning of this century, Japanese migrants introduced to the coast of São Paulo a type of fishing trap, the *cerco flutuante,* which is made of floating chambers of net (Japanese: *kaku-ami,* Von Brandt 1984) (Mussolini 1980). This fishing technique is also used at Búzios Island.

In the past agriculture was important at Búzios (Willems 1952). During the fieldwork reported here (14 months in 1986–1987), islanders spent most of their time in fishing activities. Manioc is cultivated by some families, usually for home consumption. Protein consumption comes especially from fish. The typical meal at Búzios is fish or squid with manioc flour, rice, beans, and sporadically, spaghetti (Begossi 1989a).

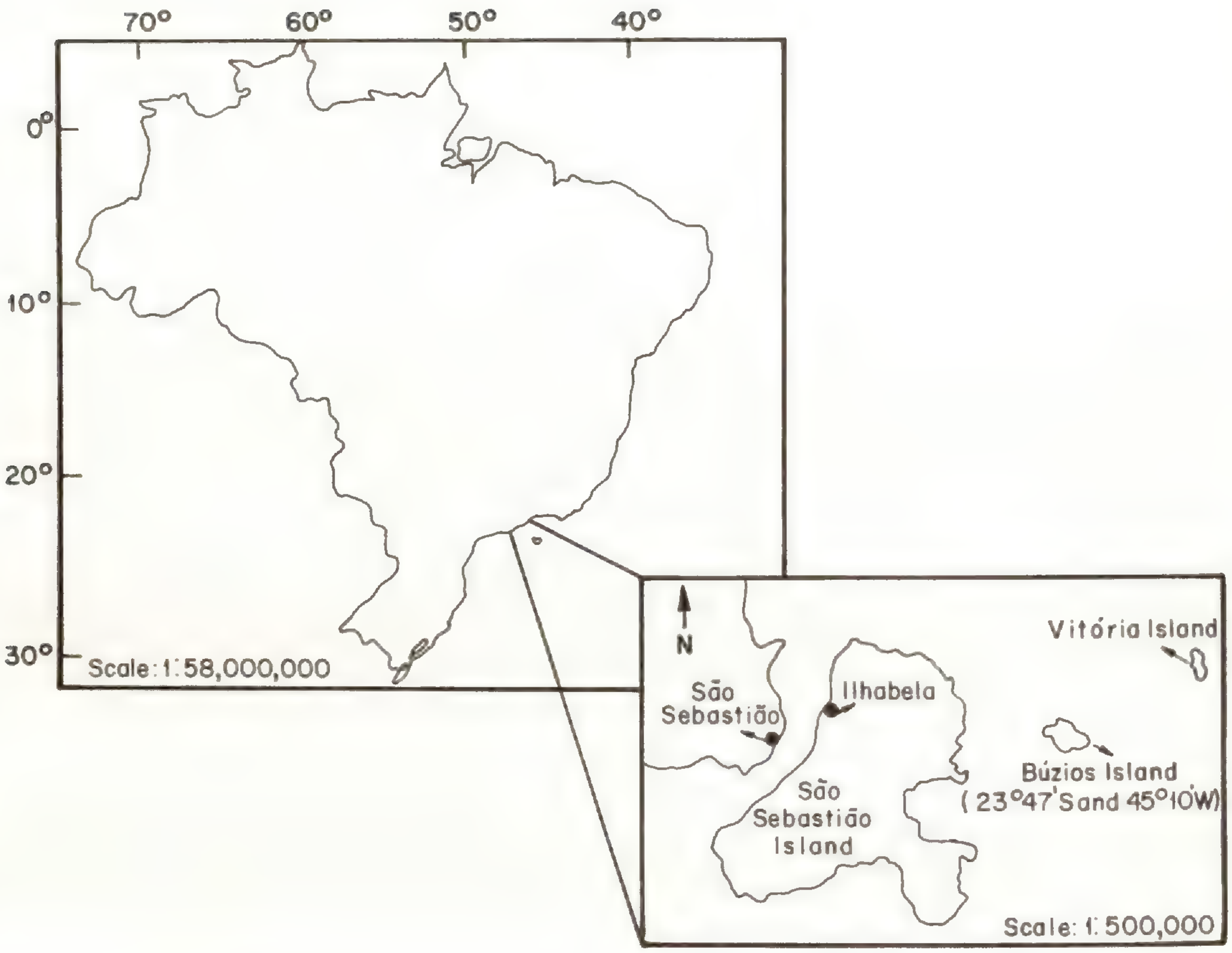


FIG. 1.—Map of Brazil showing the location of Búzios Island off the coast of São Paulo State.

## METHODS

The field work at Búzios Island included observations and interviews performed during monthly visits of about a week each from November 1986 to December 1987. A total of 88 days was spent at Búzios Island as the guest of a fishing family. I sampled the diet of 10 families from Porto do Meio during a 12 months period (5 days/month); a detailed study on fish preferences at Búzios is in Begossi (1989a).

A series of interviews were carried out as part of a broader study on diet and fishing at Búzios Island (Begossi 1989a). Interviews were made at six of the eight small harbors of the island: Porto do Meio (23 houses), Guanxuma (7 houses), Pitangueira (4 houses), Costeira (1 house), Porto do Cais (2 houses), and Mãe Joana (2 houses). The two other harbors were not included in the study due to difficulty of access. Interviews included questionnaires and were conducted when possible with all adult men and women (18 years of age or older). The first interview was made with 73 islanders (about 88% of the adult residents). This interview included the questions ''Que peixes você não come?, Porque? (What kind of fish don't you eat? Why?). Another interview, with 57 people, included questions such as ''Que peixes você não come quando está doente?'' (What kind

of fish don't you eat when you are sick?) and ''Que peixes você come quando está doente?'' (What kind of fish do you eat when you are sick?). Questions concerning medicinal animals were asked in another interview, in which 32 islanders described animals used to cure diseases or heal wounds. Informal conversations and direct observations on food taboos and folk medicine were made at Porto do Meio harbor. These included observations on foods avoided by islanders and on the preparation of home-made medicines.

Analyses of the lipid contents of fish species were based on samples of 100 gr salted and dried tissue. They were made by E.S. Contreras and J.L. Guimaraẽs of the Laboratory of Food Engineering, Universidade Estadual de Campinas, São Paulo. Details are found in Begossi (1989a).

Fish collected at Búzios Island were identified using the keys of Figueiredo (1977), Figueiredo and Menezes (1978, 1980), and Menezes and Figueiredo (1980, 1985). Identifications of molluscs were based on Rios (1985). Specimens collected were deposited at the Museu de Zoologia, Universidade de São Paulo (MZUSP).

## FISH TABOOS

The fish most strongly avoided as food by islanders from Búzios are *camburú* (moray, *Gymnothorax* spp.), *raia* (species of ray), *bonito* (bullet mackerel and little tunny, *Auxis* sp. and *Euthynnus alletteratus)*, and *tinhuna* (sargeant major, *Abudefduf saxatilis)* (Table 1). Begossi (1989a) used regression analysis to investigate the variables (calories, fish boniness, price, and availability, among others) involved in the choice of animal protein, consisting mostly of fish, by islanders from Búzios. Fish avoidances or taboos could not be explained by any of these variables.

The reasons interviewees offered for avoiding fish varied among fish species (Table 2). For example, the avoidance of *camburú* (moray) is explained by its ''snake-shape,'' bad smell, aggressive behavior, ugly appearance, and conspicuous teeth (Fig. 2). Ray avoidance had similar explanations, except that rays are not ''snake-shaped'' nor do they have teeth. In fact, aggressive behavior may help explain the avoidance of certain prey types. A fisherman at Búzios who caught three *camburú* (moray) had to leave two at sea due to the difficulty he had removing the hooks from these aggressive prey. Lenko (1965) reported that inhabitants from Búzios avoid eating *camburú* because they believe it climbs out the sea to fight the poisonous *jararaca (Bothrops* sp.), a very common snake on the island. *Bonito* (bullet mackerel and little tunny) (Fig. 2) is avoided due to presence of ''blood'' (i.e., a high concentration of hemoglobin) (Moyle and Cech 1982). *Tinhuna* is said to have a strong or bad smell.

Some fish avoided by islanders, such as bonito, ray, and shark (Table 2), are termed *carregado. Carregado* includes a set of supposed attributes of an animal, such as teeth, blood, aggressive behavior, ''strong flesh,'' fattiness *(graxa)*, and factors that could cause inflammation if eaten by someone who is wounded or unhealthy. A frequent answer during interviews was ''se comer peixe carregado a ferida inflama'' (if you eat a *carregado* fish, you will get inflammation of wounds). Women are not supposed to eat these fish during menstruation or after childbirth.

TABLE 1.—Fish avoided by at least 3% of interviewees (total number: 73) from Búzios Island.

| Names | | | Percentage of interviewees |
|---|---|---|---|
| Local | English | Scientific | practicing avoidance |
| *camburú* | moray | *Gymnothorax* spp. | 25 |
| *raia* | ray | *Raja cyclophora, Myliobates* sp., *Dasyatis* sp. (?) | 21 |
| *bonito* | mackerel, tunny | *Auxis* sp., *Euthynnus alleteratus* | 18 |
| *tinhuna* | sargeant | *Abudefduf saxatilis* | 16 |
| *cação* | shark | *Rhizoprionondon lalandei,* among other spp. | 15 |
| *corvina* | sand drum | *Umbrina coroides* | 11 |
| *garoupa* | grouper | *Epinephelus* spp. | 10 |
| *piragica* | yellow chub | *Kyphosus incisor* | 8 |
| *bagre* | catfish | *Notarius grandicassis* | 7 |
| *budião* | hogfish, parrotfish wrasse | *Bodianus* spp., *Scarus vetula, Sparisoma* spp., *Halichoeres* spp. | 7 |
| *enchova* | bluefish | *Pomatomus saltator* | 7 |
| *salema* | porkfish | *Anisotremus virginicus* | 7 |
| *bicuda* | guachanche | *Sphyraena guachancho* | 6 |
| *goete* | weakfish | *Cynoscion* spp. | 6 |
| *betara* | kingfish | *Menticirrhus americanus* | 4 |
| *espada* | cutlass fish | *Trichiurus lepturus* | 4 |
| *frade* | angelfish | *Pomacanthus paru* | 4 |
| *tainha* | mullet | *Mugil platanus* | 4 |
| *baiacú* | pufferfish | *Sphoeroides spengleri* | 3 |
| *corcoroca* | tomtate | *Haemulon aurolineatum* | 3 |
| *mamangaba* | scorpionfish | *Pontinus rathbuni* | 3 |
| *olhete* | yellowtail | *Seriola lalandi* | 3 |
| *pargo* | spadefish | *Chaetodipterus faber* | 3 |
| *sargo* | black margate | *Anisotremus surinamensis* | 3 |
| *xalerete* | bluerunner | *Caranx crysos* | 3 |
| small and rocky fishes | | | 3 |

Observations: 10% of interviewees mentioned they eat any kind of fish; 4% mentioned they usually avoid eating turtle *(Chelonia mydas);* another 4% avoid eating dolphin (Cetacea).

Moran (1974) observed that Amazon *caboclos* (people of mixed European and Indian background) have some food restrictions during illness, pregnancy, lactation, and menstruation. The foods prohibited are called hot *(quente or reimoso)*. Smith (1976, 1981) studied food habits of transamazon settlers and of *caboclos* from Itacoatiara in Amazonas State. In these cases, the fish avoided, referred to as

FIG. 2.—Some animals avoided at Búzios Island: (a) a fisherman handling a *camburú* (green moray, *Gymnothorax funebris);* (b) some Scombridae avoided are *bonito-banana* (bullet mackerel, *Auxis* sp.) (top) and *bonito-pintado* (little tunny, *Euthynnus alletteratus)* (bottom).

TABLE 2.—Explanations given by Búzios islanders about fish avoidances.

| Explanation | Fish | | |
|---|---|---|---|
| | | In case of disease | |
| | Avoided (n=65) | Avoided (n=32) | Eaten (n=8) |
| Never ate it | *baiacú, boto, camburú, raia, tainha,* turtle. | | |
| Snake-shape | *camburú* | | |
| Bad smell | *camburú, frade, garoupa, piragica, raia, tinhuna, cação* | | |
| Dangerous, aggressive | *camburú, raia, cação* | | |
| Carregado[1] | *bonito, raia, cação* | All cited in Table 3 | |
| Blood | *bonito* | *bonito* | |
| Illness, body wounds, toothaches, after child-birth[2] | *bonito, bicuda, cavala, enchova, espada, goete raia, tainha, sororoca, cação* | All cited in Table 3 | |
| Ugly, nasty | *camburú, raia* | | |
| Fatty | *garoupa, goete* | *olhete* | |
| Scaleless | *cação* | | |
| Many bones | *budião, corcoroca, jaguaricá,* small rocky fish, *sardinha, tinhuna* | | |
| It eats mud or dirty things | *corvina, timbáli* | | |
| Hard flesh | *corvina* | | |
| Soft flesh | *namorado* | | |
| Toxic | *baiacú* | | |
| Sting presence | *mamangaba* | | |
| Difficult to capture | *raia* | | |
| Bad for women: it is believed woman | *raia* | | |

| Explanation | Fish | | |
|---|---|---|---|
| | | In case of disease | |
| | Avoided (n=65) | Avoided (n=32) | Eaten (n=8) |
| explodes, visceral organs are exposed | | | |
| Conspicuous teeth | *bicuda, camburú enchova, espada, marimbá, piragica, paru, cação* | | |
| Weak flesh[3] | | *pargo, piragica* | |
| With scales | | *garoupa, marimbá, piragica, panaguaiú* | |
| Docile, not aggressive | | *garoupa, jaguariçá, marimbá, olhete, piragica, salema sargo.* | |
| Little blood | | *badejo, garoupa, marimbá, olhete cação* | |
| Tooth absence | | *cação* | |

[1]*Carregado* means with conspicuous teeth, fatty *(graxa),* with blood, aggressive, with strong flesh, or that it exacerbates any illness.

[2]Body wounds are the most cited health problem associated with the consumption of some fishes.

[3]Opposed to strong flesh or *carregado.*

Scientific names of fishes absent from other tables (mentioned by only one interviewee): *cavala (Scomberomorus cavalla), namorado (Paranthias furcifer), sardinha (Sardinella brasiliensis), timbáli (Fistularia petimba).*

Observations: Another interview, only about ray avoidance, showed that 63% of interviewees (n=30) do not eat ray, for the reasons listed above. In the interview reported here, explanations such as ''I do not like it'' are not included; scientific names are found in Tables 1, 3, and 4.

*reimoso,* are those that cannot be eaten by anyone suffering from a wound, measles, tumors, and skin rash; these fish are believed to exacerbate health problems and to have a ''strong meat.'' Pereira (1974) observed that scaleless fish *(peixes de couro)* are usually avoided in the Amazon River and that some illnesses are believed to be caused by these fish. Begossi and Braga (1992) observed similar fish avoidances by fishermen living along the Tocantins River. These

fishermen also called the avoided fish *reimoso* or *carregado*. The similarities of names and meanings of avoided fish in regions so distinctive environmentally as the Amazon and Búzios Island are worthy of investigation.

Similar food taboos have been reported in other regions of the world. Wilson (1980) reported avoidances of ray, bonito, and mackerel, among others, by Malay women after childbirth. Ferro-Luzzi (1980a, 1980b) described the avoidance of ray, shark, *Sphyraena* (same genus as *bicuda*), and *Scomberomorus* (same genus as *sororoca*) (Table 2) by pregnant and puerperal women from Talminad, India. Ecological or nutritional aspects of the species in question might help explain similar fish avoidances from such diverse communities.

## DIET RESTRICTIONS IN CASE OF DISEASE

Among the fish avoided, interviewees emphasized that some species were avoided mainly by people suffering from disease or wounds in the body (Table 2). In order to understand this type of prohibition, another set of interviews was undertaken. The most important fish avoided by unhealthy persons are *bonito* (bullet mackerel and little tunny) and *enchova* (bluefish, *Pomatomus saltator*) (Table 3). Other fish are accepted or even recommended in case of illness. The most important of these are *marimbá* (spottail pinfish, *Diplodus argenteus*) and *garoupa* (grouper, *Epinephelus* spp.) (Table 4). *Cação* (small shark) was mentioned both as a fish to be avoided and as one recommended in illnesses (Table 3 and Table 4). It is not clear if islanders were referring to different species of *cação* or if its classification is variable among islanders.

Some diseases, such as bronchial asthma and psoriasis, as well as heart attacks, are not as frequent in populations with a fish-based diet, such as the Eskimo (Lands 1986). The consumption of different species of fish might also have effects on the health of consumers.

Table 2 shows that many fish avoidances are explained by Búzios islanders by the fact that the fish are *carregado*. According to Smith (1981), *reimoso* fish are considered to be oily; many catfishes, for example, have abundant fat reserves. High fat concentration was cited by interviewees from Búzios as the reason to avoid a few types of fish (Table 2). Data on lipid contents of fish species mentioned by more than 10% of interviewees are shown in Table 5. There is no significant difference between the mean fat content of fish which are avoided and those which are eaten (ANOVA I, F, $p > 0.77$). Thus, fat content cannot explain why some fish are avoided and others are preferred as food in case of illness. Begossi and Braga (1992) found that fish avoided by fishermen living along the Tocantins River are low in calories while fish consumed and preferred by them tend to be high in calories.

Other explanations given by Búzios Islanders for avoiding certain fish during illness is that those fish have teeth. The fish commonly eaten during illnesses are considered docile (Table 2). As shown in Table 6, fish which are avoided by unhealthy persons are usually predators of other fish species. On the other hand, most fish accepted during sickness feed on invertebrates or plankton. Thus, the diet of the fish seems to determine which species islanders avoid and accept as

TABLE 3.—Fish avoided by at least 3% of interviewees (total number: 57) from Búzios for fear of exacerbating disease.

| Names | | | |
|---|---|---|---|
| Local | English | Scientific | Percentage of interviewees practicing avoidance |
| *bonito* | mackerel | *Auxis* sp. | |
| | tunny | *Euthynnus alletteratus* | 74 |
| *enchova* | bluefish | *Pomatomus saltator* | 68 |
| *xalerete* | bluerunner | *Caranx crysos* | 35 |
| *espada* | cutlass fish | *Trichiurus lepturus* | 30 |
| *cação* | shark | *Rhizoprionondon lalandei,* among other spp. | 25 |
| *bicuda* | guachanche | *Sphyraena guachancho* | 14 |
| *sororoca* | mackerel | *Scomberomorus brasiliensis* | 11 |
| *goete* | weakfish | *Cynoscion* spp. | 9 |
| *raia* | ray | *Raja cyclophora, Myliobates* sp. *Dasyatis* sp. (?) | 7 |
| *tainha* | mullet | *Mugil platanus* | 7 |
| *xaréu* | jack | *Caranx latus* | 7 |
| *jaguariçá* | squirrel fish | *Holocentrus ascensionis* | 5 |
| *camburú* | moray | *Gymnothorax* spp. | 4 |
| *olhete* | yellowtail | *Seriola lalandi* | 4 |

Observation: Nine percent of interviewees mentioned that they avoid eating any fish while ill.

food when they are ill. Invertebrate or plankton feeders are said to have "weak flesh," i.e., a kind of meat that does not exacerbate health problems. Smith (1981) observed that fish considered *reimoso* are those which eat all kinds of creatures. Most fish avoided by people from the Tocantins River region are carnivorous whereas consumed and preferred fish are usually herbivorous or detritivorous (Begossi and Braga 1992). Some fish can be especially unhealthy if they occasionally eat other venomous fish. The probability of acquiring (and accumulating) toxins increases in higher trophic levels. These toxins may be pollutants, such as heavy metals, or natural substances, such as those obtained by eating toxic plankton, invertebrates, or fish.

## TOXIC FISHES

Most families at Búzios consider *baiacú* (pufferfish, *Sphoeroides spengleri)* to be venomous (Lenko 1965). Pufferfish poisoning has been reported since the seventeenth century (e.g., Piso 1658). Actually, tetrodoxin, a neurotoxin, is present

TABLE 4.—Fish favored by at least 3% of interviewees (total number: 57) from Búzios during illness.

| Names | | | Percentage of interviewees |
|---|---|---|---|
| Local | English | Scientific | |
| *marimbá* | spottail | *Diplodus argenteus* | 47 |
| *garoupa* | grouper | *Epinephelus* spp. | 44 |
| *piragica* | yellow chub | *Kyphosus incisor* | 37 |
| *cação* | shark | *Rhizoprionondon lalandei*, among others | 16 |
| *sargo* | black margate | *Anisotremus surinamensis* | 16 |
| *panaguaiú* | halfbeak | *Hemiramphus balao* | 14 |
| *tinhuna* | sargeant | *Abudefduf saxatilis* | 12 |
| *salema* | porkfish | *Anisotremus virginicus* | 11 |
| *corcoroca* | tomtate | *Haemulon aurolineatum* | 7 |
| *jaguariçá* | squirrel fish | *Holocentrus ascensionis* | 7 |
| *olhete* | yellowtail | *Seriola lalandi* | 5 |
| *badejo* | black grouper | *Mycteroperca bonaci* | 4 |
| *budião* | hogfish, parrotfish wrasse | *Bodianus* spp., *Scarus vetula, Sparisoma* spp. *Halichoeres* spp. | 4 |
| *olho de boi* | amberjack | *Seriola dumerili* | 4 |
| *pargo* | porgy | *Calamus penna, Pagrus pagrus* | 4 |
| *xalerete* | bluerunner | *Caranx crysos* | 4 |

Observations: A total of 14% of interviewees don't consume any special fish in case of illness. Another 5% mentioned chicken as a food for ill persons.

in liver, ovaries, and skin glands of pufferfish (Gopalakrishnakone 1988; Watabe et al. 1987). Species of *bonito* (Fig. 2), rays, and sharks are also avoided at Búzios (Table 1, Table 3). According to islanders, the meat of *bonito* deteriorates very rapidly. Mackerel-like fishes, tunas, skipjacks, and *bonitos,* if not adequately preserved, may be occasionally poisonous—a toxic substance is formed within the body musculature (Russell 1965)—and shark muscles have been mentioned as toxic, as has the liver of other elasmobranchs (Hashimoto 1979). Fish taboos of this kind have also been reported in India and Malaysia (Ferro-Luzzi 1980a, 1980b; Wilson 1980).

More than 500 fish species have been reported to cause intoxication in humans; their distribution favors the tropical seas (Habermehl 1981). These fish tend to occur more frequently around islands than along continental shores (Russell 1965). Much of the available information on the distribution of toxic fish is based on

TABLE 5.—Lipid content of some fish species from Búzios Island.

| Fish | | Percentage Lipids | Total Solids (gr) |
|---|---|---|---|
| AVOIDED | | | |
| *camburú* | *Gymnothorax* spp. | 9 | 64 |
| *bonito* | *Euthynnus alletteratus* | 3 | 58 |
| *raia* | *Dasyatis* sp. (?) | 1 | 63 |
| *corvina* | *Umbrina coroides* | 4 | 56 |
| *tinhuna* | *Abudefduf saxatilis* | 3 | 72 |
| *cação* | *Sphyrna* sp. | 1 | 54 |
| MEAN | | 4 | — |
| AVOIDED DURING ILLNESS | | | |
| *cação* | *Sphyrna* sp. | 1 | 54 |
| *bonito* | *E. alletteratus* | 3 | 58 |
| *enchova* | *Pomatomus saltator* | 3 | 57 |
| *xalerete* | *Caranx crysos* | 13 | 61 |
| *espada* | *Trichiurus lepturus* | — | — |
| *sororoca* | *Scomberomorus brasiliensis* | — | — |
| *bicuda* | *Sphyraena guachancho* | — | — |
| MEAN | | 5 | — |
| ACCEPTED DURING ILLNESS | | | |
| *cação* | *Sphyrna* sp. | 1 | 54 |
| *piragica* | *Kyphosus incisor* | 6 | 54 |
| *marimbá* | *Diplodus argenteus* | 5 | 61 |
| *garoupa* | *Epinephelus* sp. | 6 | 58 |
| *salema* | *Anisotremus virginicus* | 7 | 59 |
| *tinhuna* | *A. saxatilis* | 3 | 72 |
| *panaguaiú* | *Hemiramphus balao* | 2 | 48 |
| *sargo* | *Anisotremus surinamensis* | 3 | 59 |
| MEAN | | 4 | — |

Sample base: 100 gr of salted and dried tissue (Begossi 1989a). Only fish mentioned by more than 10% of interviewees are included.

which fish local inhabitants believe to be toxic and on the locations where these fish are caught (Lewis 1984), rather than on an objective evaluation of toxicity and distribution. A list of some toxic species is shown in Table 7. Many of these species occur around Búzios Island.

TABLE 6.—Feeding habits of fish avoided and eaten during illness by islanders.

| Fish | Family | Feeding habit[1] |
|---|---|---|
| AVOIDED | | |
| *bonito* | Scombridae | fish and squid |
| *cação* | Carcharhinidae[2] | carnivorous |
| *enchova* | Pomatomidae | fish |
| *xalerete* | Carangidae | small fish: herrings and anchovies |
| *espada* | Trichiuridae | fish |
| *sororoca* | Scombridae | fish and squid |
| *bicuda* | Sphyraenidae | fish and crustacea |
| EATEN | | |
| *cação* | Carcharhinidae[2] | carnivorous |
| *piragica* | Kyphosidae | invertebrates, vegetal matter |
| *marimbá* | Sparidae | algae, crustacea, molluscs |
| *garoupa* | Serranidae | fish |
| *salema* | Pomadasyidae | annelids, crustacea, molluscs, ophiuroids |
| *tinhuna* | Pomacentridae | plankton, invertebrates |
| *panaguaiú* | Exocoetidae | zooplankton |
| *sargo* | Pomadasyidae | crustacea, equinoderms, small fish |

[1]Data are from Figueiredo and Menezes (1980), Menezes and Figueiredo (1980) and Moyle and Cech (1982).

[2]This is the most common family; other families are Sphyrnidae and Odontaspididae. Fish cited by more than 10% of interviewees are included. Scientific names are found in Tables 3 and 4.

*Ciguatera* has not been reported for southeast Brazil, nor are there known cases of fish intoxication in this region. However, information is lacking on the food habits of fishing populations and on their experience with toxins. Also, fish mentioned as avoided by a reasonable proportion of interviewees (Table 1 and Table 3) are known to cause poisoning in man in other regions. As pointed out by Lewis (1984), fish not valued as food in a particular locale may be ciguatoxic, but not yet identified as such scientifically. *Ciguatera* poisoning is usually found in the

TABLE 7.—Some poisonous fishes. Data compiled from Rosenberg (1987) and Russell (1965).

| Fish name | | | |
|---|---|---|---|
| Local | English | Scientific | Occurrence[1] |
| *baiacú* | puffer | *Sphoeroides* (14 spp.) | G |
| | bandtail puffer | *Sphoeroides spengleri* | S |
| *barracuda* | barracuda | *Sphyraena* (7 spp.) | G |
| *bicuda* | guachanche | *Sphyraena guachancho** | S |
| *budião* | hogfish | *Bodianus rufus** | S |
| | parrotfish | *Scarus* (7 spp.) | G |
| | | *Scarus vetula** | S |
| | wrasse | *Bodianus bilunulatus* | G |
| *cação, tubarão* | dog fish | *Squalus acanthias* | B |
| | spiky jack | *Squalus fernandinus* | B |
| | hammerhead | *Sphyrna zygaena** | G |
| *camburú* | moray eel | *Gymnothorax* (9 spp.) | G |
| | | *Gymnothorax funebris** | S |
| | | *Gymnothorax moringa** | S |
| *caranha* | snapper | *Lutjanus* (28 spp.) | G |
| | | *Lutjanus cyanopterus** | S |
| *garoupa* | grouper | *Epinephelus* (8 spp.) | G |
| | | *Epinephelus morio** | S |
| *jaguariça* | squirrel fish | *Holocentrus ascensionis* | S |
| *olho de boi* | amberjack | *Seriola aureovitta* | G |
| | | *Seriola dumerili* | S |
| *peixe-porco* | file fish | *Aluterus monoceros** | S |
| | | *Alutera scripta* | G |
| *raia* | lesser electric ray | *Narcine brasiliensis* | B |
| | spotted stingray | *Aetobatus narinari* | B |
| | stingray | *Dasyatis* (22 spp.) | G |
| | eagle ray | *Myliobates* (6 spp.) | G |
| *xalerete* | bluerunner | *Caranx crysos** | S |
| *xareú* | horse-eye jack | *Caranx latus* | S |
| | cardinal fish | *Apogon* sp. | G |
| | jack crevalle | *Caranx hippos* | G |
| | | *Mugil cephalus** | G |
| | | *Mycteroperca tigris** | G |
| | | *Upeneus arge** | G |

[1]S: species collected at Búzios Island; G: genera found at Buzios; B: genera or species found in SE Brazil (based on Figueiredo 1977).

*Species responsible for ciguatera poisoning (Russell 1965).

Pacific Islands, on the coasts of the United States, and in the Caribbean (Habermehl 1981; Russell 1965). It is caused by the ingestion of fish with ciguatoxin (Hashimoto 1979). This neuromuscular toxin is acquired by fish through the ingestion of the bottom-dwelling dinoflagellate *Gambierdiscus toxicus* (Lewis 1984; Miller et al. 1987). According to Lewis (1984), *ciguatera* is highly unpredictable because toxic individuals are indistinguishable from non-toxic ones.

Over 300 fish species of the families Acanthuridae, Aluteridae, Balistidae, Carangidae, Chaetondontidae, Labridae, Lethrinidae, Lutjanidae, Muraenidae, Scaridae, Serranidae, and Sphyraenidae have been implicated in *ciguatera* fish poisoning (Habermehl 1981). The most common are the high level carnivores and omnivores, such as *Sphyraena barracuda, Gymnothorax javanicus, Lutjanus bohar,* large *Caranx,* Epinephelinae, and reef sharks (Lewis 1984; Quod and Legrand 1988). The avoidance of top carnivores by islanders from Búzios (Table 6) could be the result of a cautious diet; when a person is unhealthy avoidances (taboos) are adhered to more strictly. According to Russell (1965), in cases of ciguatoxin, while both herbivorous and carnivorous fishes can cause *ciguatera,* the latter are more toxic and, in some areas, they are the only sufficiently toxic fish to cause poisoning in man. Kodama and Hokama (1989) pointed out that, in cases of *ciguatera,* carnivorous fishes may concentrate toxins and even modify them biochemically leading to the formation of other variants of toxins. Moreover, other kinds of toxins which may result in fish avoidances may be still undetected.

## OTHER FOOD TABOOS AND FOLK MEDICINAL ANIMALS

Among the available animal protein at Búzios Island, beef (usually dry meat: jerky), followed by fish and chicken are the items preferred by fishing families (Fig. 3). However, fish are the items consumed most frequently (Begossi 1989a). Dry meat is expensive and cannot be a common item of diet except for the most prosperous households in Porto do Meio Harbor. Among the animals avoided by islanders, the most important are lizard, octopus, turtle, and squid. Lizard *(teiú, Tupinambis teguixin),* in particular, is avoided as food by 96% of interviewees (Fig. 3, Fig. 4).

At Búzios Island the taboo concerning lizard consumption is the strongest of all animal protein avoidances. The ''incidence of horror'' (Rea 1981; Turton 1978) to lizard is strong. Islanders usually spit on the ground when they see or talk about this animal. This behavior expresses how nasty and dirty the lizard is in their point of view.

Lizards are the main source of protein and fat for some human populations, such as the aborigines living in the northern part of the Great Sandy Desert, Australia (Cane 1987). Other populations, such as some from the Sonoran Desert, avoid eating lizards (Rea 1981).

Lizard is a high caloric meat (293 kcal. in 100 gr salted and dried tissue, Begossi 1989a), but families at Búzios only use lizard fat for medicinal purposes. It is used to treat *jararaca (Bothrops* sp.) bites and to cure rheumatism (Table 8 and Fig. 4), among other ailments. In northeast Brazil, lizard fat is used against snake-bites, asthma, and throat pains (Campos 1967). In 1658, Piso reported that lizard

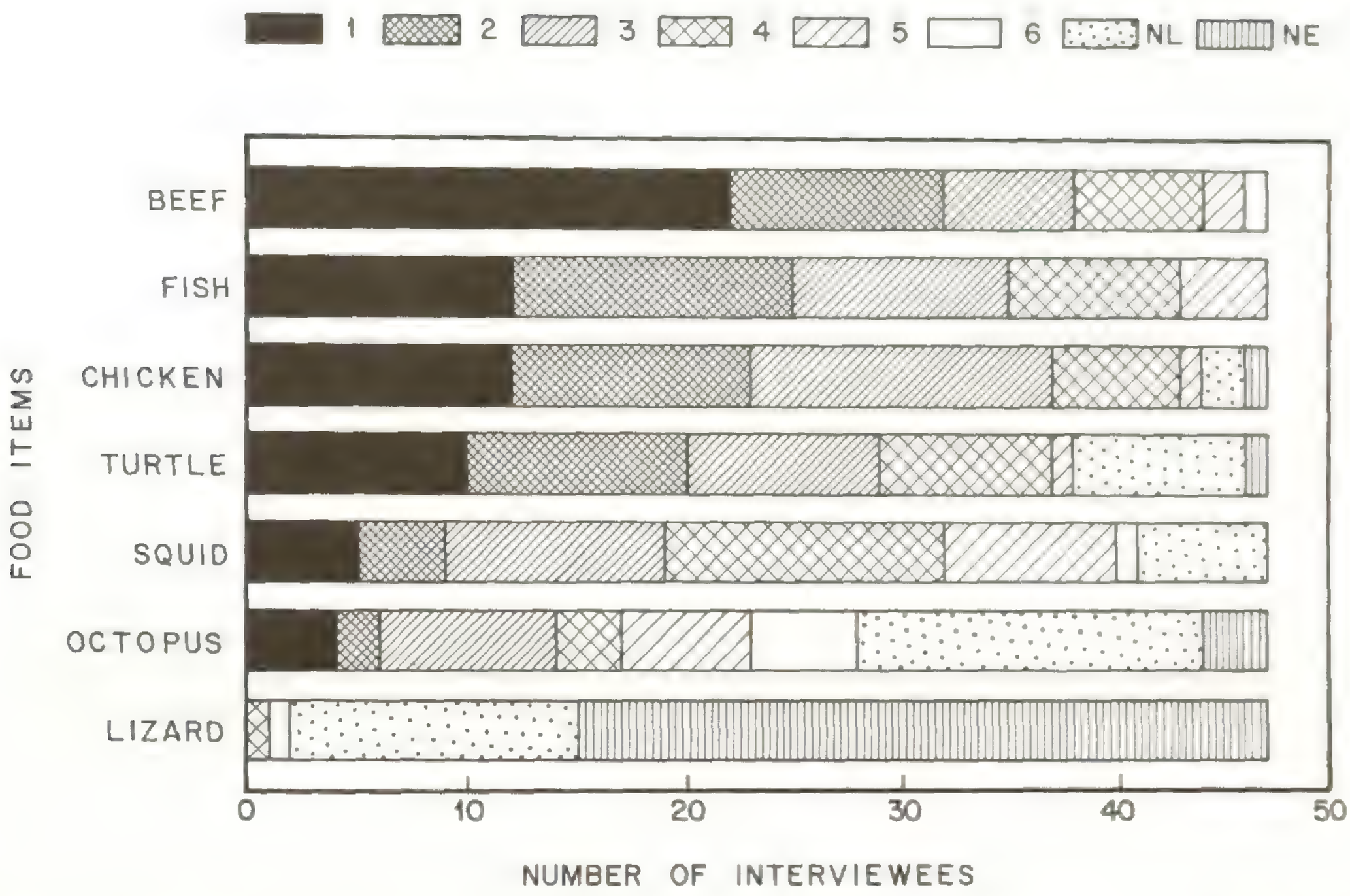


FIG. 3.—Preference of animal protein: results from interviews (n=47). Bars are coded (1—6) to show the animal protein ranking given by islanders; NL = does not like it, NE = does not eat it in any way.

FIG. 4.—*Teiu* (lizard, *Tupinambis teguixin):* this animal is strongly avoided as food, but its fat is used against snake-bites and to cure rheumatism.

TABLE 8.—Medicinal animals cited in interviews (n=32). Bold face indicates more important usages and animal part used.

| Name[1] | Percentage response | Scientific name | Diseases | Utilization |
|---|---|---|---|---|
| (S) *lagarto, teiu* (lizard) | 81 | *Tupinambis teguixin* | **snake-bites** **rheumatism** asthma tetanus **skin thorns** | The **fat** *(enxundia)* is drunk with water or applied on the affected area. Meat is eaten for snake bites of *Bothrops* sp. |
| (S) *tartaruga* (turtle) | 47 | *Chelonia mydas* | bronchitis asthma rheumatism | The **heart** is toasted and tritured. The powder is drunk with water and/or tobacco. For rheumatism, the fat is massaged on the affected area. |
| (N) *cavalinho* (sea horse) | 34 | *Hippocampus reidi* | **bronchitis** women's hemorrhages after childbirth | Toasted and drunk as a tea or with *pinga* (Brazilian rum) |
| (C) chicken | 22 | *Gallus gallus* | cough bronchitis asthma | The **fat** is massaged on chest or drunk with water. |
| (N) *almofadinha, barata do mar* (ray eggs) | 13 | *Raja cyclophora* | women after childbirth: hemorrhages | **Eggs** are toasted and drunk as tea or with *pinga*. |
| (S) *caramujo* (snail) | 9 | *Megalobulinus* sp. | wounds | The **shell** is toasted and tritured. The powder is applied on wounds. Toasted meat may be used the same way. Can be drunk with water. |
| (N) *peixe morcego* (batfish) | 3 | *Ogcocephalus vespertilio* | bronchitis | ? |

| Name[1] | Percentage response | Scientific name | Diseases | Utilization |
|---|---|---|---|---|
| (S) *ouriço do mar, mana-carú* (sea urchin) | 3 | *Lytechinus variegatus* | snake-bites (*Bothrops* sp.) | It is tritured; the green juice is drunk. |
| (N) *cobra* | 3 | (?) (snake) | against bad luck *(mau-olhado)* | The skin is toasted and drunk with water. |
| (C) *jaguariçá* (squirrelfish) | 3 | *Holocentrus ascensionis* | body wounds | The stinger is put in contact with wounds. |
| (N) *limo do fundo do mar* | 3 | algae (?) | bronchitis | Used to make syrups |

[1]Code before name indicates consumption pattern: (N)—not consumed; (S)—seldom consumed; and (C)—consumed.

fat was used to cure skin wounds. The observation that the most disgusting animal for Búzios islanders is also the most important in medicinal terms reinforces the argument suggested by Harris (1977), that food taboos may work to "avoid temptation." Or, in other words, a strong taboo against the consumption of lizard will help to maintain its availability for medicinal uses.

At Búzios Island, ray and other fish *(cavalinho, peixe morcego,* and *jaguariçá* Table 8) were described as medicinals. The medicinal utilization of sea horse *(Hippocampus* sp.) as an emmenagogue at Búzios Island had already been observed by Lenko (1965). Fishermen from the Tocantins River region use a broader diversity of fish than do Búzios islanders to cure diseases and many of these are also avoided as food. For example, fat of *raia (Potamotrygon* spp. and *Disceus thayeri)* is used for asthma; fat from *jaú (Paulicea lutkeni)* for skin burns, and that of *poraquê (Electrophorus electricus)* for rheumatism (Begossi and Braga 1992).

Other animals avoided as food, such as turtle *(Chelonia mydas)*, are also used for medicinal purposes (Table 8). Campos (1967) reported the use of *cagado* (fresh water turtle) against rheumatism in northeast Brazil. Ayres and Ayres (1979) reported that *caboclos* from Aripuaña (southern Amazon) avoid eating *onça parda (Felis concolor,* cougar) due to its medicinal value.

## CONCLUSIONS

The fish avoided as food at Búzios Island are fish with aggressive behavior, a bad odor, or those classified as *carregado,* such as *camburú* (moray), ray, *bonito* (bullet mackerel and little tunny), and *tinhuna* (sargeant major). *Carregado* are fish

avoided during illness; there are other species of fish which are recommended for ill persons. These are mostly fish that feed on invertebrates or plankton. The *baiacú* (pufferfish) is also considered toxic and is not eaten at Buzios. Other medicinal animals are subject to food taboos; the most tabooed is the lizard, which has the greatest medicinal value.

As pointed out by Ross (1978), food taboos may be explained by ecological adjustments in resource exploitation. Costs and benefits of foraging strategies can offer explanations that go beyond solely cultural explanations. The avoidance of some animals as foods may be partially explained by the importance of maintaining them for medicinal purposes. According to the ''drugstore hypothesis'' (Begossi 1989b; Begossi and Braga 1992), nature is the ''drugstore'' of isolated human populations; plants (collected and cultivated) as well as animals are used for medicinal purposes. As is the case for Harris's (1977, 1985) sacred cow, medicinal animals are also too important to be consumed as food. Note that the strongest food taboo pertains to the lizard, which is the most frequently used medicinal animal (Table 8). According to Rea (1981), a dietary restriction does not necessarily protect an animal from human predation, as it may still be taken for its feathers, hide, or medicinal/religious value. At Búzios, if medicinal animals were also consumed, predation pressure would be stronger on these animals. Therefore, the maintenance of a species through food taboos may also have utilitarian purposes.

Food avoidances and taboos express the perceptions that a community has about its environment. Islander perception is that some fish are ''healthy'' and others ''unhealthy.'' This behavior could be based on an old or a present environmental feature. A taboo may at first be useful. Once in existence, it develops an inertia of its own and may no longer be adaptive (Carneiro 1978). Taboos are like cultural traditions which do not change instantly in response to environmental conditions (''cultural inertia'') (Boyd and Richerson 1985).

Ross (1978) observed that Upper Xingu Basin (Brazil) populations which depend heavily on fishing have dietary restrictions concerning terrestrial game animals. On the other hand, fish is insignificant in the diet of Yanomano, Shuara (Jivaro), and Mundurucú populations, and large game restrictions are absent. Ross concluded that where aquatic fauna is abundant, aquatic organisms are prized as food and land creatures are considered inedible. However, Kiltie (1980) suggested, based on optimal foraging theory, that food taboos should not depend on prey availability, but rather on the ranking of food preferences.

According to optimal foraging theory (Pyke 1984), when resources are abundant a predator should specialize in high ranking prey; if resources are scarce low ranking prey are included in the diet. If we consider that fishing communities such as Búzios Island have plenty of available animal protein, we should expect to find the low ranking prey being avoided in these communities (i.e., they will specialize in some animal protein items). As suggested by Rea (1981), taboos are a luxury: for example, rich riverine peoples with agriculture can afford them but peoples from harsh areas have to be more generalist in their food choices. The ranking and choice of resources, in association with the other factors already discussed, could favor the creation and maintenance of food taboos at Búzios.

Three main factors are potentially related to animal food avoidances at Búzios Island. First, some fish are avoided because they can be toxic (pufferfish, for example) or they could have been toxic in the past (e.g., ciguatoxin; no available data). Second, fish that prey on other fish are avoided by unhealthy persons. Third, some animals are avoided as food because they are preserved for medicinal purposes (e.g., lizard, ray, and turtle). The same factors seem to explain food behaviors of fishermen along the Tocantins River (Begossi and Braga 1992). However, data on fish toxins are much needed in order to understand better the factors which affect food taboos in human populations. Finally, the similarity of taboos on fish such as ray, shark, and *bonito* in communities from Brazil (Búzios Island and Tocantins), India, and Malaysia should be considered the result of possible ecological or nutritional factors.

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## BOOK REVIEW

**Las Plantas y el Hombre: Memorias del Primer Simposio Ecuatoriano de Etnobotánica y Botánica Económica.** Montserrat Ríos and Henrick Borgtoff Pederson (editors). Quito, Ecuador: Ediciones ABYA–YALA, 1991. Pp. xxiv, 437. No price given (paperback). ISBN 9978–99–002–X.

Ethnobotanists often lament the difficulty of finding out what transpired at conferences they have not attended; even when published, the proceedings are often out-of-date by the time they see the printed page. Ríos and Pederson are to be congratulated for their efficiency in issuing this compendium of papers presented at the First Ecuadorian Symposium of Ethnobotany and Economic Botany, held in Quito from 27 February–2 March, 1990.

The volume contains papers written by 45 contributors representing eight countries. Of a total of 33 articles, five are written in English and 28 in Spanish; abstracts are given in both languages. The papers are divided among three sections: (1) conservation and management of useful plants; (2) medicinal plants; and (3) ethnobotany and its application.

As with most symposium proceedings, the range of topics is diverse and the quality of the papers uneven. Many are based on research carried out in Ecuador, but some contributions describe projects in Mexico, Colombia, and other Latin American countries. Others range further afield; the inclusion of a paper on the potential use of Bedouin birth control plants to subdue the fecundity of rodents is especially curious.

Although most focus on the ethnobotany of particular species or indigenous groups, a number of papers are broad enough to be of general interest. Castillo T. gives an account of the primary plant genetic resources of Ecuador and discusses a local program for their conservation *ex situ*. Pederson, a Danish botanist with extensive experience in Ecuador, presents an informative summary of the nation's wild palms. Estrella, initiator of the symposium, describes the Ecuadorian food plants in use before the arrival of the Spanish. A well-written essay by Davis recaps the history of ethnobotany and describes its trajectory.

Several contributions are brief summaries of broad, ongoing research projects: country-wide inventories of medicinal plants in Mexico (Aguilar C.) and Honduras (House) and comparative ethnobotany in the northern sierra of Puebla, Mexico (Martinez A.), among others. One hopes that these "tip of the iceberg" accounts will soon be followed by monographic treatments.

The 22-page bibliography is particularly valuable for ethnobotanists who work in South America; many articles of limited distribution are included. Indices of scientific and vernacular names are useful for readers interested in folk classification or in a particular taxonomic group.

The book was copublished by the Herbario QCA, Departamento de Ciéncias Biológicas, Pontificia Universidad Católica del Ecuador, Quito, Ecuador. Inquiries should be addressed to the editors at this address.

Gary J. Martin
Anthropology Department
University of California
Berkeley, CA 94720

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## SHORT COMMUNICATION

# SOME OBSERVATIONS ON THE USE OF MEDICINAL PLANTS FROM PRIMARY AND SECONDARY GROWTH BY THE RUNA OF EASTERN LOWLAND ECUADOR

EDUARDO O. KOHN
*32 Sturges Way*
*Princeton, NJ 08540*

Amazonian rain forests are often depicted in the popular literature as ''drug stores,'' with the implication that indigenous peoples use them much like city-dwellers go to the corner pharmacy for an aspirin or some other remedy. Recent observations I made on the medical culture in a Runa (Quichua-speaking Indian) community in eastern lowland Ecuador challenge this notion. Indeed, numerous primary forest taxa are recognized medicinals but few receive frequent use. An examination of medicinal plant usage patterns revealed secondary vegetation as a much richer source of useful species.

Observations on medicinal plant use were made from February to July 1990 in Río Blanco (Napo province, 77°40′W; 1°00′S, 440 m elevation), a small Runa settlement (population ca. 100). Río Blanco residents hunt, fish, and grow crops such as manioc, and peach palm (*Bactris gasipaes* H.B.K., Arecaceae). Panned gold, coffee, cacao, and corn are sold in order to purchase items such as salt, gun powder, machetes, clothing, and Western medicines. Despite the availability of Western goods including remedies, the Runa continue to rely heavily on medicinal plants. Runa medical culture is examined in greater depth elsewhere (Kohn 1992).

In order to determine usage patterns, medicinal plants were classified according to the habitat in which they were collected: primary forest ***(rucu sacha),*** secondary forest ***(mauca),*** and garden ***(chagra).*** Most secondary forest plots in Río Blanco are the result of agricultural disturbances created as much as 25 years ago when the area was first settled. Primary forest taxa are occasionally present in these plots because of sparing and transplantation.

The classification of medicinal plants by habitat confirmed an expected parallel and revealed an unanticipated paradox. Although medicinal plant occurrence paralleled the general trend of increased species diversity during forest succession, the importance of a plant assemblage as a source of remedies was not related to the number of useful species within it, indicating that other factors determine usage patterns. Fifty-four percent of the 191 medicinal species collected (Table 1) occurred in primary forest, 29% were growing in secondary forest, and 17% occurred in gardens (Fig. 1). However, medicinals from secondary forest and gardens were more frequently used than those from primary forest. I observed applications with 25 different taxa: 40% of these were collected in gardens, 36% in secondary forest, and 24% came from primary forest (Fig. 2). Thirty-one

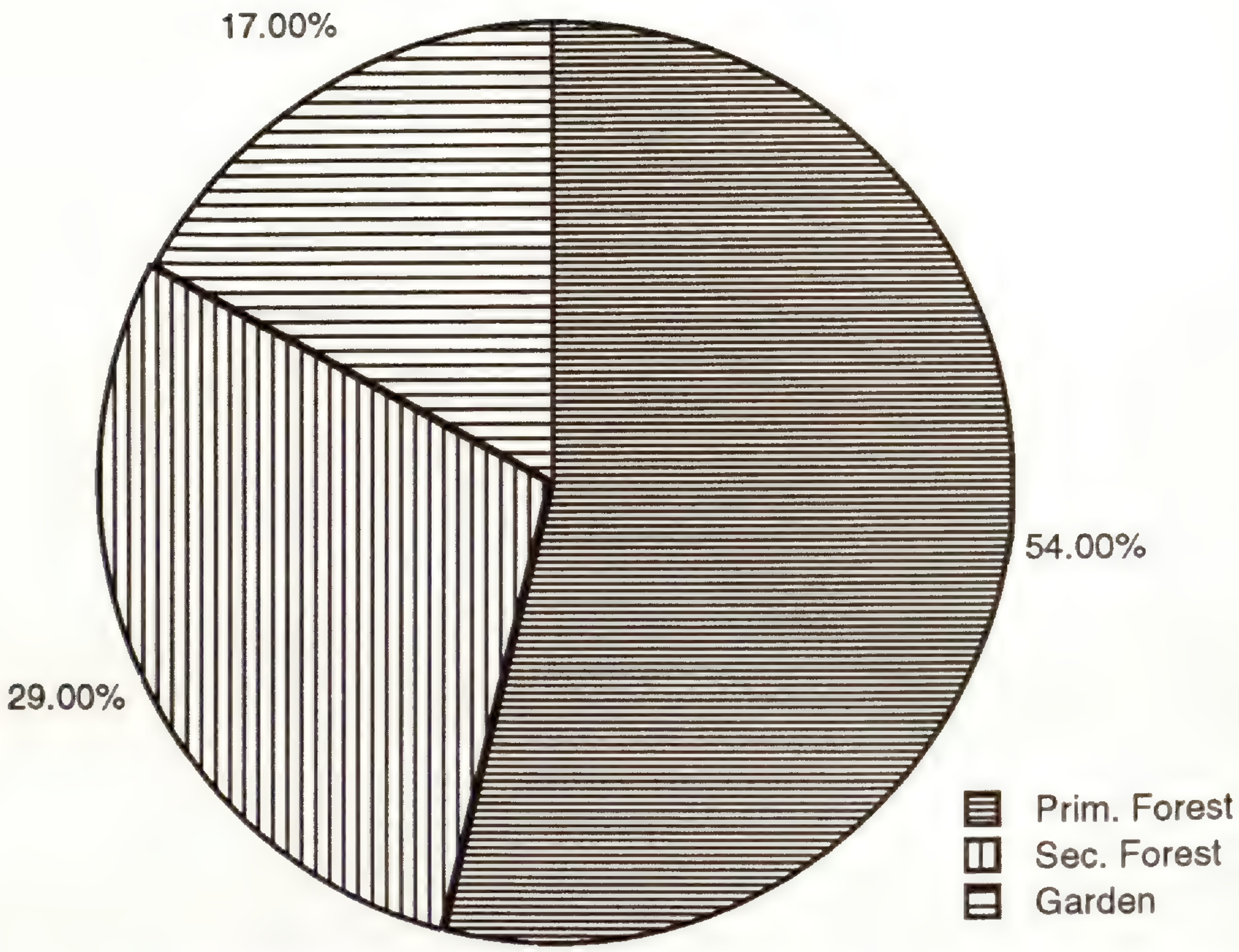


FIG. 1.—The distribution of the collected medicinals according to the habitat in which they were found.

percent of the 32 garden medicinals collected and 16% of the 56 secondary forest medicinals were observed being used. Only 6% of the 103 primary forest taxa were observed in use (Fig. 3).

Although medicinals appear to be incorporated into the Runa materia medica because of efficaciousness—Marles et al. (1988) found pharmacological and chemical literature supporting traditional plant uses for 28% of the species they collected among the Runa of Napo province—other considerations encourage disproportionate reliance on plants from disturbed habitats. Plant conspicuousness, cultural taboos, multipurpose utility, and ease of transplantation may encourage the use of some medicinals instead of others.

Early successional species tend to be gregarious and thus more conspicuous and accessible than the often highly dispersed forest taxa. Furthermore, although primary forest occurs no more than 200 m from any doorstep, the Runa do not venture lightly into the forest—the home of potentially dangerous spirits ***(supai)***—and do so only to accomplish specific tasks. Women and children rarely enter the forest alone.

Frequently used plants are also cultivated in gardens and other disturbed areas and many have multiple uses. For example, a variety of preparations of the cultigen ***tahucu*** *(Nicotiana tabacum* L., Solanaceae) are used medicinally: cigar smoke is blown over patients during shamanistic curing sessions; moistened leaves are administered as an emetic; tobacco juice is aspirated nasally to treat head colds

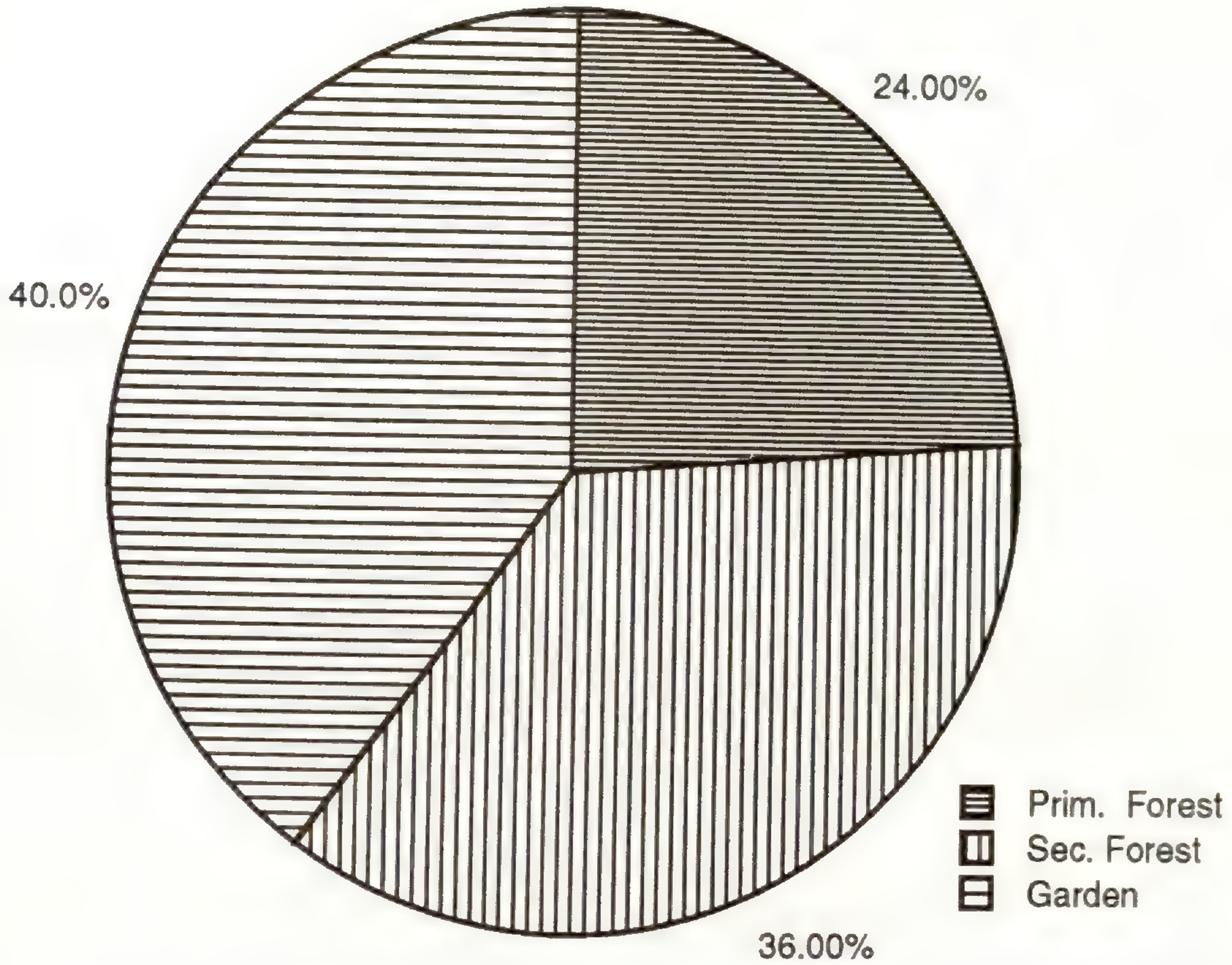


FIG. 2.—The distribution of medicinal plants whose application was observed according to the habitat in which they were collected.

and drunk as a narcotic; tobacco resin is used to expel subcutaneous ***hualun curu*** (probably *Dermatobia hominis)* larvae; and poultices are applied to treat a variety of ailments ranging from chest pains to infected blisters.

For convenience, frequently utilized forest medicinals are often transplanted to disturbed areas. Of the 34 species recorded in cultivation, eight had recently been transplanted from primary forest. Some transplants, such as ***dunduma*** (*Cyperus* sp., Cyperaceae), ***ajus huasca*** (*Mansoa* cf. *alliacea* (Lam.) A. Gentry, Bignoniaceae), ***amarun caspi*** (*Ouratea* sp., Ochnaceae), ***yahuar purungu panga*** (*Mikania* sp., Asteraceae), and ***tahucu sisa*** (Campanulaceae), are cultivated in open gardens. Others, such as ***machacui huishu*** (*Malpighia* cf. *glabra,* Malpighiaceae), are planted beneath secondary growth or in plantings of coffee intercropped with cacao and peach palm, presumably because these associations duplicate late successional habitats from which the taxa were transplanted. Still other transplants, such as ***mati cara*** (*Clavija* sp., Theophrastaceae) and ***curarina*** (*Potalia amara* Aublet, Loganiaceae), are more broadly tolerant and persist as resources in fallowed areas. However, not all primary forest medicinals are easily transplanted. Río Blanco residents have been unable to cultivate the commonly used midcanopy tree ***chucchu huasha*** (*Maytenus* sp., Celastraceae) apparently because, like many other climax taxa, it is drought sensitive. Furthermore, slow-growing late successional plants may not produce useful quantities of secondary metabolites for several decades, making cultivation impractical.

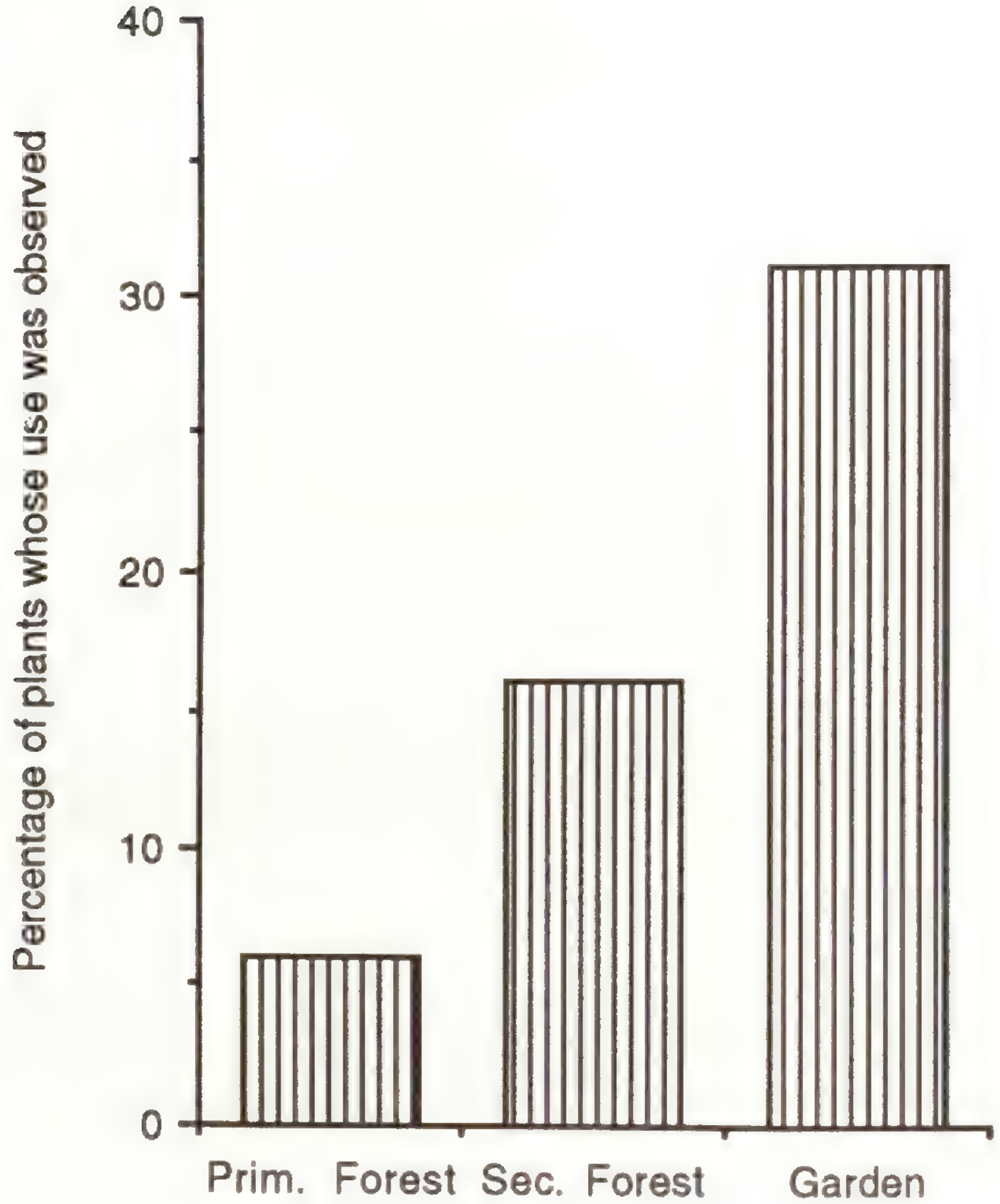


FIG. 3.—The percentage of plants from each habitat whose application was observed.

The high species diversity of primary forest and the many medicinals found there have encouraged observers to overemphasize climax taxa and to underrate the importançe of secondary communities to native pharmacopoeias. Primary forest is certainly an important resource but more so as a source of medicinal propagules than as a "drug store." Surveys elsewhere would determine whether the pattern of plant usage in Río Blanco is a general one among Amazonians.

## ACKNOWLEDGEMENTS

I am grateful for the kindness with which the people of Río Blanco received me during my stay in their community. I received support for my research from the A.W. Mellon Research Fund and the Jerome Davis Research Fund at Oberlin College. My collections (Eduardo Kohn 1001–1314) are deposited at the Missouri Botanical Garden with duplicates in the herbarium of the Museo Ecuatoriano de Ciéncias Naturales in Quito. I am indebted to the botanists at both of these institutions, in particular David Neill, for determining these collections. I thank David Benzing for reviewing earlier drafts of this manuscript.

TABLE 1.—Medicinal plants collected in Río Blanco. The common Quichua or Spanish name is given after the Latin name. This information is followed by: the habitat in which the plant was collected; the way in which the plant is used or the malady for which it is said to be useful; and whether the author observed the plant in use.

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| *Abuta grandifolia* | payanchi yurac, yahuate caspi | Secondary forest | diarrhea, regulate menstruation | Yes |
| *Acacia glomerosa* | huaranga | Primary forest | colds | Yes |
| *Acalypha* sp. | ita quhuilchic | Secondary forest | diarrhea, bloody diarrhea | No |
| *Allophylus* sp. | cambia | Primary forest | snake bite | No |
| Amaryllidaceae | sacha cebolla | Garden | tumors | No |
| Annonaceae | lichihua yurac pechiche | Primary forest | cataracts | No |
| Annonaceae | remo caspi, pinja cara | Primary forest | body pains, diarrhea, stomach ache | No |
| *Anthurium ernestii* | zingra panga | Primary forest | arthritis, rheumatism | No |
| *A. pendulifolium* | suni zingra panga | Primary forest | arthritis, rheumatism | No |
| *A. polyschistum* | not given | Primary forest | topical parasitic and fungal infections | No |
| *Anthurium* sect., *Pteromischum* sp. nov. | not given | Primary forest | love magic | No |
| *Anthurium* sp. | pasumu panga, concordia | Primary forest | postpartum inflammations, pains, malaise | No |
| *Anthurium* sp. | yami panga | Primary forest | applied to the legs of children with difficulty walking | No |
| *Aristolochia* sp. | saragosa | Primary forest | diarrhea, cough, stomach ache | No |
| Asteraceae | aya huachi | Secondary forest | acne, hypopigmentation | No |
| *Bactris* sp. | ucu mari chunda | Primary forest | sore joints | No |
| *Banisteriopsis caapi* | aya huasca | Secondary forest | hallucinogen | Yes |
| *Batocarpus* sp. ? | negro caspi | Primary forest | tonic | No |
| *Batocarpus* sp. ? | sacha paparahua | Primary forest | infected wounds | No |
| *Bauhinia* sp. | yacu yutsuc | Primary forest | diarrhea | No |
| *Begonia parviflora* | bibitsic | Secondary forest | inflammations | No |
| *Begonia* sp. | auru panga, pungi panga | Primary forest | medicinal | No |
| *Bixa orellana* | manduru | Secondary forest | accelerate birth | No |
| *Blechum browneii* | quibiu quihua | Garden | sprains | Yes |
| *Bolbitis* sp. ? | cutu chupa | Secondary forest | diarrhea | No |
| *Brosimum utile* | pucuna caspi | Primary forest | vermifuge | No |
| *Brownea* sp. | cruz caspi | Primary forest | regulate menstruation | No |
| *Brugmansia* sp. | huantuc | Garden | body pains, inflammations | No |
| *Brugmansia* sp. | sasi huantuc | Garden | hallucinogen, body pains | No |

TABLE 1. (continued)

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| *Brunfelsia* cf. *grandiflora* | sacha chiri huayusa | Primary forest | postpartum fevers, body pains, emetic, narcotic, hunting luck, colds | No |
| *B. grandiflora* | chiri huayusa | Garden | postpartum fevers, body pains, emetic, narcotic, hunting luck, colds | No |
| *Brunfelsia* sp. | sacha chiri huayusa | Primary forest | postpartum fevers, body pains, emetic, narcotic, hunting luck, colds | No |
| *Caladium* sp. | hualun mandi | Secondary forest | expel bot fly larvae | No |
| *Calliandra angustifolia* | ichilla yutsu, chiparo pequeño | Primary forest | diarrhea | No |
| *Calyptranthes* sp. | sani mulchi | Primary forest | menstruation, hemorrhage | No |
| Campanulaceae | tahuco sisa | Garden | liver ailments, tumors | No |
| *Campelia zanonia* | quilun quilun | Secondary forest | cuts | No |
| *Capsicum* sp. | uchu | Garden | expel illness-bringing spirits from the body and house, diarrhea | Yes |
| *Carludovica palmata* | lisan | Secondary forest | ''zingra'' (rheumatism?) | No |
| *Cephaelis* sp. or *Psychotria* sp. | chiri panga | Primary forest | rattle/fan for curing ceremonies | Yes |
| *Cephaelis williamsii* | yan chipi panga | Primary forest | colds | No |
| *Citrus* sp. | limun | Garden | diarrhea, nausea, fever | Yes |
| *Clavija* sp. | mati cara | Garden | snake bite | No |
| *Clavija* sp. | llushti mati cara | Secondary forest | snake bite | No |
| *Clavija* sp. | jatun mati cara | Primary forest | snake bite | No |
| *Clidemia heterophylla* | uchan | Primary forest | body pains, stomach ache, colds | No |
| *Clidemia* sp. | uchan | Primary forest | body pains, stomach ache, colds | No |
| *Columnea* sp. | dumbiqui callu panga | Secondary forest | hemorrhages, reduce menstrual flow | No |
| Commelinaceae | shungu nanai panga, supi panga | Primary forest | liver | No |
| *Cordia nodosa* | araña caspi | Primary forest | snake and spider bites, infections | No |
| *Costus* sp. | sacha iru | Primary forest | diabetes | No |
| *Coussarea* sp. | pungi panga yurac | Primary forest | gas | No |
| *Croton lechleri* | lan iqui, sangre de drago | Secondary forest | cuts, anemia, kidney, stomach | Yes |
| Cucurbitaceae | chia | Secondary forest | scabies | No |
| *Cuphea* sp. | ichilla panga shica | Primary forest | arthritis | No |
| *Cyathea* sp. | pichichi | Primary forest | cuts, mumps? | No |
| *Cyclanthus bipartitus* | tsicta, papancu | Primary forest | snake bites, cataracts | No |

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| *Cymbopogon citratus* | hierba luisa | Garden | stomach ache, headache, body pains | No |
| *Cyperus* sp. | dunduma | Garden | diarrhea | No |
| *Desmondium axillare* | llutari quihua batan quihua | Secondary forest | hemorrhages, menstrual irregularities | No |
| *Desmoncus* sp. | bara casha | Primary forest | tumors | No |
| *Dicranopygium* sp. | yucu lisan | Primary forest | arthritis, rheumatism | No |
| *Dieffenbachia* cf. *daguense* | chaha lalo | Primary forest | luck | No |
| *Dieffenbachia* sp. | chaha lalo | Primary forest | hunting luck | No |
| *Diplopterys cabrerana* | chali panga huasca | Secondary forest | hallucinogen | No |
| *Dracontium* cf. *loretense* | machacui mandi | Primary forest | snake bite | No |
| *Dracontium* sp. | machacui mandi | Secondary forest | snake bite | No |
| *Eschweilera* sp. | cushillu manga cara | Primary forest | tuberculosis | No |
| *Eugenia* cf. *subterminalis* | yana muyu mulchi | Primary forest | cavities, menstrual irregularities, diarrhea | No |
| *Ficus* sp. | plor ila | Primary forest | diarrhea | No |
| *Ficus* sp. | puca ila, higueron | Primary forest | vermifuge | No |
| *Fittonia verschaffeltii* | nina curu panga yahuar panga | Primary forest | "caracha" cutaneous parasites | No |
| *Fittonia* sp. | yahuar panga | Primary forest | fishing luck | No |
| *Geonoma* sp. | macana panga | Primary forest | abdominal pains from overexertion | No |
| Gesneriaceae | gallu panga, yahuar sisa panga | Primary forest | hemorrhages, snake bites | No |
| Gesneriaceae | gallu sisa quihua, puca panga | Primary forest | menstruation | No |
| Gesneriaceae | gallu sisa | Primary forest | menstruation | No |
| Gesneriaceae | inda paju panga | Secondary forest | infection | No |
| *Grias neuberthii* | piton | Primary forest | emetic, malaria, hunting luck, postpartum abdominal pains | No |
| *Guadua* sp. | huama | Secondary forest | inflammations | No |
| *Gurania* sp. | sapallu panga, ahuas panga | Primary forest | scabies | No |
| *Heliconia aemygdiana* | lliquiri siqui panga | Secondary forest | accelerate birth | No |
| *Heliocarpus americanus* | damua | Secondary forest | accelerate birth | No |

TABLE 1. (continued)

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| *Herrania* sp. | sacha cambia | Secondary forest | snake bite | No |
| *Hyptis pectinata* | caballu quihua | Garden | tuberculosis | No |
| *Hyptis* sp. | chiquis quihua, chagras quihua, albahaca | Secondary forest | cough, fever, contraceptive | No |
| *Ilex guayusa* | huayusa | Garden | stimulant, mouth rinse, pains, fever, labor pains, mixed with hallucinogen *Banisteriopsis caapi* | Yes |
| *Inga edulis* | pacai, guaba | Secondary forest | colds | No |
| *Iriartea deltoidea* | pushiua | Primary forest | warts | No |
| *Iryanthera* sp. | sicu huapa | Primary forest | diarrhea, to stop menstruation | No |
| *Jacaranda glabra* | cupa panga yurac | Primary forest | scabies | No |
| Lauraceae | anis ahua | Primary forest | colds, cough, stomach ache | No |
| *Leonia glycycarpa* | tamia muyu yurac | Primary forest | mumps | No |
| *Libadeum* sp. | yacu maria panga | Primary forest | arthritis | No |
| *Lomariopsis japurensis* | chunda huasca | Primary forest | abortive, hasten menstruation | No |
| *Lonchocarpus nicou* | timun ambi | Secondary forest | ichthyotoxin, expel spirits, poison to commit suicide | Yes |
| *Macfadyena uncata* | tuta pishcu sillu | Secondary forest | hunting and love magic | No |
| *Maieta guianensis* | uchan | Primary forest | body pains, stomach ache, colds | No |
| *Malpighia* cf. *glabra* | machacui huishu | Garden | snake bite | No |
| Malvaceae | escobilla | Garden | headache | No |
| *Mansoa* cf. *alliacea* | ajus huasca | Secondary forest | colds, body pains, fevers, measles | No |
| *Mayna odorata* | ichilla mati cara | Secondary forest | snake bites | No |
| *Maytenus* sp. | chucchu huasha | Primary forest | stomach ache, diarrhea, body pains, anemia | Yes |
| Melastomataceae | puca paytsic panga | Secondary forest | skin infections | Yes |
| *Miconia* sp. | ahua paytsic | Primary forest | diarrhea | No |
| *Mikania* sp. | yahuar purungu panga | Garden | snake bites, cuts, menstruation | No |
| *Mollinedia* sp. | urcu chiri huayusa | Primary forest | medicinal | No |
| *Monolena* sp. | urti tullu | Primary forest | colds | No |
| *Monstera sprueana* | iqui quihua, suelda con suelda | Primary forest | anemia, inflammations | No |

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| Moraceae | chinchi yurac | Primary forest | tumors | No |
| *Myroxylon balsamum* | balsamo yurac | Secondary forest | diarrhea, colds | No |
| *Nicotiana tabacum* | tahucu | Garden | ritual cleansing, sore muscles, head colds, sore throats, sinus congestion, narcotic, colic, body pains, tonic, "shungu rigushca paju," bot fly larva, protection from snake venom | Yes |
| *Orthostichopsis tortipilis* | tuca | Primary forest | cuts, internal pains, stomach ache, avoid being poisoned by snake venom | No |
| *Otoba parvifolia* | huapa yura iqui | Primary forest | diarrhea | No |
| *Ouratea* sp. | ichilla cara amarun caspi | Primary forest | diarrhea, postpartum abdominal pains, menorrhagia | No |
| *Pariana* sp. | zuru panga | Garden | rattle/fan for curing ceremonies | No |
| *Parkia multijuga* | sutanga | Primary forest | hypopigmentation | No |
| Pedaliaceae | virgin mama sisa | Garden | accelerate birth | No |
| *Petiveria alliacea* | condiciun panga | Garden | colds, cough | No |
| *Philodendron* sp. nov. ? | sacha lalo | Primary forest | malaise, inflammations, internal body pains, hunting luck | No |
| *P.* cf. *uleanum* | nan ambi huasca | Primary forest | snake bite | No |
| *Philodendron* sp. nov. | lalo | Primary forest | hunting luck | No |
| *Philodendron* sp. possibly nov. | ichilla zingra panga | Primary forest | rheumatatism, arthritis | No |
| *Phytolacca* cf. *rivinoides* | huataracu muyu | Secondary forest | tuberculosis | No |
| *Piper* sp. | shia, armallu ringri panga | Primary forest | diarrhea, nausea | No |
| *Piper* sp. | Santa María de anis | Garden | colds, body pains | No |
| *Piper* sp. | urcu shia | Primary forest | diarrhea, nausea | No |
| *Piper* sp. | mucu tullu yurac | Secondary forest | diabetes | No |
| *Piper* sp. | chugri yuyu | Primary forest | cuts | No |
| *Piper* sp. | basu panga | Primary forest | hernia | No |
| *Piptadenia* sp. | chunda rucu paju yurac, urcu tamburu | Primary forest | blisters | No |
| *Piptadenia* sp. | asna huaranga | Secondary forest | diarrhea | Yes |
| *Plagiochila* sp. | tuca | Primary forest | cuts, internal pains, stomach ache, avoid being poisoned by snake venom | No |

TABLE 1. (continued)

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| Poaceae | shinglu | Secondary forest | rheumatism, whooping cough | No |
| *Polybotrya crassirhizoma* | cutu chupa | Secondary forest | diarrhea | No |
| *Portulaca* sp. | chucli quihua | Garden | kidney, diabetes | No |
| *Potalia amara* | curarina | Secondary forest | snake bites | No |
| *Pothomorphe peltata* | cari maria panga | Garden | tooth ache, colds, inflammations | No |
| *P. umbellata* | maria panga | Garden | inflammations, tooth ache, colds | Yes |
| *Pouteria caimito* | abiyu | Garden | rattle/fan for curing ceremonies, scabies | No |
| *Protium nodulusum* | siri quillu | Primary forest | colds | No |
| *Psychotria viridis* | sami ruca | Garden | mixed with the hallucinogen *Banisteriopsis caapi* | No |
| *Renealmia* sp. | ichilla shiguango | Secondary forest | snake bite | No |
| *Renealmia* sp. ? | jatun shiguango | Secondary forest | snake bite | No |
| *Retiniphyllum* sp.? | urcu matiri | Primary forest | rheumatism, hunting luck, colic | No |
| *Rheedia* sp. | pungara | Primary forest | scabies, ''charas'' | No |
| *Rheedia* sp. | chunda rucu mulchi | Primary forest | postpartum colic | No |
| *Ricinus communis* | atalpusamuyu | Secondary forest | arthritis | No |
| Rubiaceae | mucu caspi yurac | Primary forrest | tonic | No |
| *Salpichlaena volubilis* | urcu tutayu | Primary forest | diarrhea | Yes |
| *Scleria* sp. | shinglu | Secondary forest | colds | No |
| *Selaginella exaltata* | hualumbu huasca | Primary forest | colds, cough | No |
| *S. geniculata* | zancudo quihua | Primary forest | insect repellent | No |
| *Serjania* sp. | chunda rucu paju huasca, rayu huasca | Secondary forest | ''chunda rucu paju'' blisters | Yes |
| *Siparuna* sp. | malagri panga | Secondary forest | infections | No |
| *Siparuna* sp. | mal agri panga | Secondary forest | infections | No |
| *Smilax* sp. | quilambu casha | primary forest | tumors | No |
| *Smilax* sp. | quilambu casha hausca | Primary forest | cataracts, diarrhea | No |
| Solanaceae | asna panga yurac, ataqui panga | Primary forest | epilepsy | No |
| Solanaceae | pupu huasca | Primary forest | avoid bleeding from umbilical chord | No |
| Solanaceae | apumpu cara | Secondary forest | measles | No |

| Scientific Name | Common Name | Habitat | Use | Use Ob. |
|---|---|---|---|---|
| Solanaceae | yacu huantuc | Primary forest | medicinal | No |
| Solanaceae | yacu caspi | Secondary forest | headache | No |
| Solanaceae? | illa huanga butui | Secondary forest | tuberculosis | No |
| *Solanum* sp. | ataqui panga, asna panga | Primary forest | epilepsy | No |
| *Solanum* sp. | nina curu paju panga | Secondary forest | ''nina curu paju'' (a parasitic skin infection) | Yes |
| *Solanum* sp. | inda paju panga | Secondary forest | ''ituc paju'' (a parasitic skin infection) | No |
| *Sparattanthelium glabrum* | dunduma huasca | Secondary forest | stomach ache, diarrhea, malaria, body pains | Yes |
| *Spathiphyllum* sp. | hualun mandi | Primary forest | expel bot fly larvae | No |
| *Spigelia* sp. | cuica quihua | Garden | vermifuge | Yes |
| *Swartzia simplex* | negro caspi | Primary forest | tonic | No |
| *Tabernaemontana sananho* | tsicta | Primary forest | labor pains | No |
| *Tabernaemontana* sp. | uchu tsicta | Primary forest | skin irritations | No |
| *Thelypteris angustifolia* | suni panga shica | Primary forest | arthritis | No |
| *Theobroma bicolor* | patas | Secondary forest | diarrhea | Yes |
| *T. cacao* | cacao | Secondary forest | hypopigmentation | No |
| *Tococa* sp. | uchan | Primary forest | medicinal | No |
| *Tournefortia* sp. | tsaca huasca, sacha purutu huasca | Garden | infections | No |
| *Tovomitopsis membranacea* | uhu angu yurac | Primary forest | colds | No |
| *Tovomitopsis* sp. ? | uhu angu | Primary forest | colds | No |
| *Urera lacinata* | chunda chini | Primary forest | body pains, measles | Yes |
| *Urera* sp. | papaya chini | Garden | body pains, stomach ache | Yes |
| Urticaceae | biu chini | Secondary forest | ''huairashca,'' measles | No |
| Valerianaceae | tucsi quihua, api quihua | Garden | sharp internal pain | No |
| Verbenaceae | virvina | Garden | malaria, diarrhea, fever | No |
| *Vernonia patens* | liunchic, chilca | Secondary forest | eye irritation, diarrhea, fever, bronchitis | No |
| *Weigeltia* sp. | sacha tahucu | Primary forest | body pains, headache, malaise, hunting luck | Yes |
| *Witheringia solanacea* | zimbiyu yurac panga | Secondary forest | malaria, diarrhea, inflammations, scabies, | No |
| *Zingiber officinale* | ajiringri | Garden | diarrhea, nausea, stomach ache | Yes |
| Undetermined | nina curu paju yurac | Secondary forest | ''nina curu paju'' (a parasitic skin infection) | |
| Undetermined | nina curu panga | Secondary forest | eye infections | No |

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MARLES, ROBIN J., DAVID A. NEILL, and NORMAN R. FARNSWORTH. 1988. A contribution to the ethnopharmacology of the lowland Quichua people of Amazonian Ecuador. Revista de la Academia Colombiana de Ciencias Exactas, Físicas, y Naturales 63(16):111–120.

*J. Ethnobiol.* 12(1):153–156 Summer 1992

# SHORT COMMUNICATION

# USE OF CINDER CONK *(Inonotus obliquus)* BY THE GITKSAN OF NORTHWESTERN BRITISH COLUMBIA, CANADA

LESLIE M. JOHNSON GOTTESFELD
*Department of Anthropology*
*University of Alberta*
*Edmonton, Alberta T6G 2H4*

The Gitksan Indians of northwestern British Columbia, Canada, gathered the ''sterile conks'' of the cinder conk fungus, *Inonotus obliquus* (Pers.: Fr.) Pilat (Hymenochaetaceae) (Holsten et al. 1985; Gilbertson and Ryvarden 1986). These massive black eruptions of fungal tissue externally resemble charred cork; under the dark crust they are a yellowish-brown color and have a corky texture. They emerge from cankers on living birch trees *(Betula papyrifera* Marsh.) (Fig. 1 and Fig. 2). The crusty sterile conk was broken off the trunk for use. Cinder conk had

FIG. 1.—*Inonotus obliquus* sterile conk growing on living *Betula papyrifera* Marsh. stem, Cedarvale, British Columbia, Canada.

FIG. 2.—*Inonotus obliquus* sterile conk in section showing yellowish brown interior and black surface. Collected from living *Betula papyrifera* stem, Quesnel, British Columbia, Canada.

two principal uses: for moxibustion treatment of swollen athritic joints, and as tinder or a slow match for making and transporting fire. Use of cinder conk for moxibustion continues; use for a slow match has been supplanted by matches and other modern means of kindling fire.

After conversations with a Gitksan elder who described the use of this unusual fungal structure, I collected specimens of cinder conk and brought a collection of the fungus to the elder to verify the identification. A voucher *(Gottesfeld Eth. 54,* ALTA) is deposited with the University of Alberta Herbarium.

The Gitksan have two words for cinder conk: ***mii'hlw*** and ***tiiuxw***. I am uncertain if these words have distinct meanings; they may represent intervillage dialect variants with the same meaning. A Gitksan elder describes cinder conk and its

medicinal use as follows: *''Mii'hlw*—the black growth from the crack in the birch tree. Like yellow cotton inside. If you cut it off, use the yellow cotton stuff. Take a sliver like a match stick and burn it for pain in joint.'' (interview notes, 2/20/87). According to the elder, after the sliver of cinder conk was burned to the skin on the affected joint, a special salve was then applied to the burn wounds. This treatment was reported to be effective in reducing the swelling, and presumably the discomfort, of the joint. Another Gitksan informant reported that his grandmother applied pitch after burning cinder conk slivers to treat her arthritic knee.

A handful of cinder conk was used by the Gitksan as a slow match. It was carried as an ember to kindle a new fire. ''Bring fire from the morning camp fifteen or twenty miles. Wrap in birch bark. Light fire in the evening. It remains an ember for a long time. It doesn't smoke.'' (interview notes, 2/20/87).

Three other Indian groups of northern and northwestern North America also named and used cinder conk. The Wet'suwet'en of northwest British Columbia have two names for cinder conk *(dicic'ah ci'ists'o'* and *tl'eyhtsë).* The identification and names were verified by showing pieces of a sterile conk to an elder from Hagwilget Village (interview notes, 6/14/89). She described a moxibustion treatment using cinder conk similar to that used by the neighboring Gitksan. The Wet'suwet'en also used it as a slow match. This use is recalled in a traditional tale where an abandoned girl is secretly left a wrapped ember of cinder conk to start a fire.

According to Kari (1987), the Tenaina of southcentral Alaska used cinder conk, which they call *k'atnitsayi,* for a punk or tinder with a fire drill, as a slow match, and for treatment of toothache. A beverage could also be made by soaking the cinder conk in hot water. Although Kari does not provide a taxonomic identification, the photograph, description, occurrence, and uses leave no doubt as to the identity of the fungus.

Leighton (1985) reports that the Woods Cree of east–central Saskatchewan used both *Inonotus obliquus* and *Fomes fomentarius* for moxibustion treatment of arthritis. In addition, *I. obliquus* was used to make a tea.

## ACKNOWLEDGEMENTS

Thanks are due to David Green, Charles Austin, Marianne Austin, and David Harris for sharing information on the names and uses of cinder conk. I thank Dr. Randy Currah for verifying my identification and Brenda Callan of the Pacific Foresty Centre in Victoria, B.C. for providing the photograph for Fig. 2. The manuscript was improved by reviews by Nancy Turner, Brenda Callan, and Duncan Morrison.

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HOLSTEN, EDWARD H., PAUL E. HENNON, and RICHARD A. WERNER. 1985. Insects and diseases of Alaskan forests. USDA Forest Service, Forest Pest Management, State and Private Forestry, Alaska Region Report No. 181.

KARI, PRISCILLA RUSSELL. 1987. Tenaina Plantlore. Denai'ina K'et'una. An Ethnobotany of the Dena'ina Indians of Southcentral Alaska. 2nd rev. ed. National Park Service, Alaska Region, Anchorage.

## LITERATURE CITED (continued)

LEIGHTON, ANNE L. 1985. Wild plant use by the Woods Cree (Nitihawak) of East-Central Saskatchewan. The National Museum of Man Mercury Series, Canadian Ethnology Service Paper No. 101.

# BOOK REVIEW

**Economic and Medicinal Plant Research: Volume 4: Plants and Traditional Medicine.** H. Wagner and Norman R. Farnsworth (general editors); Olayiwola Akeerele and Charlotte Gyllenhaal (volume editors). London: Academic Press, 1990. Pp. xv, 174. $69.95 (hardcover). ISBN 0–12–730065–1.

Some books are designed as encyclopedic compendia of all the available knowledge on a particular subject, while others are meant to offer brief tidbits of information to spark the readers' interest and prompt further investigation. This book is definitely in the latter category. The subject addressed is so broad that many weighty tomes would be necessary to cover every aspect of it. These 174 pages merely scratch the surface. Brevity, however, can have its advantages, in that it can focus attention on key aspects of the problem.

This book was meant to aid in the internationalization of research on medicinal plants, to create a dialog among countries, and to further interest on the evaluation, utilization, and conservation of medicinal plants. The body of the book consists of eight chapters, each dealing with a specific country (China, Ghana, India, Japan, Mexico, Panama, Samoa, and Thailand). The authors of the chapters are experts on the ethnopharmacology of that particular nation. Each author was asked to give a brief summary of the traditional medical system prevalent in the country, then to identify five or six species which seemed to merit further attention. For each plant chosen, some important aspects of the plant's uses and constituents are discussed. The treatments of the traditional medical systems give general overviews of the theoretical framework in which the medicines are used and identifies areas for further investigation.

The final chapter by Alexander M. Schmidt outlines the procedures used by the United States Food and Drug Administration in assessing the effectiveness and safety of new pharmaceuticals and addresses the problem of why traditional medicines rarely gain approval. While not following the structure of the rest of the book, this chapter does provide some useful background information on what sets the U.S. apart from other countries where herbal medicines are used more frequently. It also helps clarify some of the obstacles preventing the more widespread utilization of such plants or their extracts.

This book cannot satisfy the need for a standard reference volume since it only whets the readers' appetite. This function, however, it does quite well.

Joseph E. Laferrière
Marion Ownbey Herbarium
Washington State University
Pullman, WA 99164–4309

# NEWS and COMMENTS

**BOOK REVIEWERS NEEDED**.—The following titles have been received for review in the *Journal of Ethnobiology*.

**ARZIGIAN, CONSTANCE M., ROBERT F. BOSZHARDT, JAMES L. THELER, ROLAND L. RODELL, and MICHAEL J. SCOTT.** 1989. Human adaptation in the upper Mississippi Valley: A study of the Pammel Creek Oneota site (47LC61), La Crosse, Wisconsin. The Wisconsin Archeologist Vol. 70, Nos. 1–2. Monograph of the University of Wisconsin–La Crosse, Mississippi Valley Archaeology Center, Wisconsin Archeological Society, Office of Publications, P.O. Box 1292, Milwaukee, Wisconsin 53201. 280 pp.

**CARTER, JOSEPH G., and WILLIAM J. CARTER.** 1990. Folk Dentistry: Cultural Evolution of Folk Remedies for Toothache. The University of North Carolina, Chapel Hill. 104 pp.

_____. 1990. Herbal Dentistry: Herbal Dental Remedies from Ancient Times to the Present Day. The University of North Carolina, Chapel Hill. 77 pp.

**COHEN, MARK NATHAN.** 1989. Health and the Rise of Civilization. Yale University Press, New Haven and London. 285 pp.

**HANSEN, JULIE M.** 1991. The Palaeoethnobotany of Franchthi Cave. Excavations at Franchthi Cave, Greece, Fascicle 7. T.W. Jacobsen (general editor). Indiana University Press, Bloomington and Indianapolis. 280 pp.

**REVEL, NICOLE.** 1990, 1991, 1992. Fleurs de Paroles. Histoire Naturelle Palawan, I, II, III. Editions Peeters, Louvian, Belgium. (Text in French.) 904 pp.

**SHIPEK, FLORENCE CONNOLLY.** 1991. Delfina Cuero. Her Autobiography. An account of Her Last Years and Her Ethnobotanic Contributions. Ballena Press, Menlo Park, California. 98 pp.

If you would like to review any of these books and would be able to have your review completed within four months after receiving the book, please write to:

Nancy J. Turner
Book Review Editor for the *Journal of Ethnobiology*
Environmental Studies Program
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University of Victoria
Victoria, British Columbia
CANADA V8W 3P4

## CALL FOR MEMBERS

We are pleased to announce the formation of the Society for Phytolith Research, whose goals are to disseminate new information in phytolith research and to promote interdisciplinary contacts among researchers. Dues are $10 per year for regular members and $7.50 for students; members will receive *The*

*Phytolitharien Newsletter*. Please make checks payable (in U.S. funds) to the Society for Phytolith Research and send to:

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## NEW PUBLICATION

The publication *Index Seminum 1991: Jardín Botánico Estatal, México* is now available from the Universidad Autónoma del Estado de Morelos. To obtain more information, write to:

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MEXICO

## SOCIETY FOR ARCHAEOLOGICAL SCIENCE SYMPOSIUM: A SUMMARY

A Society for Archaeological Science symposium—''Phytolith analysis in the 1990s: Applications in archaeological interpretation''—was presented at the 1992 Society for American Archaeology meeting in Pittsburgh by co-chairs Susan Mulholland and Amy Ollendorf (both from the University of Minnesota). The nine papers dealt with various aspects of phytolith analysis as applied to archaeological problems, and several concentrated on the systematic information gleaned from cultivated plants. For example, in ''Identifying rice *(Oryza sativa)*, Poaceae, through phytolith analysis,'' Deborah Pearsall (University of Missouri-Columbia), Elizabeth Dinan, and Marcelle Umlauf reported on the results of an on-going study of wild and domesticated *Oryza* and related genera in Asia. And in ''Phytoliths in the reproductive structures of teosinte and maize: Implications for the study of maize evolution,'' Dolores Piperno (Smithsonian Tropical Research Institute), compared phytolith production in maize with that in teosinte. Finally, Marsha Baenziger and Zhao, Zhijun (both from the University of Missouri-Columbia) presented ''Clues in the search for the millets of the past: Opal phytoliths and how they may tell the story,'' which summarized the differences between the *Setaria* and *Panicum* genera of millet.

Interesting research also was reported on extraction procedures. Zhao, Zhijun presented the results of his analysis of sediment extraction procedures—including the comparison of three heavy liquids—in his paper entitled ''A new procedure for extracting phytoliths from soil.'' Likewise, William Middleton (University of Wisconsin) reported on the extraction of phytoliths from tooth calculus in his presentation titled ''Extraction of phytoliths from prehistoric and contemporary camelid dental calculus.''

The remaining papers of the SAS symposium highlighted some of the wide range of phytolith–analysis applications that are available to the archaeologist. In ''Phytolith analysis at archaeological sites for recovery of subsistence data and identification of stains,'' Linda Scott Cummings (Paleoresearch Laboratories) covered a wide range of studies, including analysis of stains, grinding stones, agricultural fields, and knives. Cesar Veintimilla (University of Missouri–Columbia) and Deborah Pearsall's paper, ''A preliminary analysis of past vegetation in the Jama River valley, Manabi Province, Ecuador,'' presented the results of their reconstruction of the vegetation in the valley, including a discussion of slash-and-burn methods of land clearing. In ''Paleoenvironmental implications from an Archaic site in southwestern Chiapas: The phytolith evidence,'' Cynthia Pope (University of Texas) and John Jones (Smithsonian Tropical Research Institute) presented the results from a similar study, but they focused on the results that are available from quick (four–hour) processing methods. Finally, Irwin Rovner of North Carolina State University spoke on ''Phytolith Problems in Transdanubian Archaeology,'' and he illustrated how to resolves the Festucoid (Pooid) phytolith shapes question with computer–assisted microscopy.

For more information on phytolith analysis, including the Society for Phytolith Research, write to Susan Mulholland at the following address:

Archaeometry Lab
University of Minnesota
10 University Drive
Duluth, MN 55812
(218) 726-7957 / BITNET
SMULHOLL @ UMDUL / internet smulholl @ ub.d.umn.edu

# NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting recent issues of the *Journal*. If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

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Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Gary J. Martin, 94 Blvd. Flandrin, 75116, Paris, France. FAX: 33/1/45533001.

## BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal*. Please send suggestions, comments, or reviews to one of the *Journal's* book review editors. Please see inside front cover for names and addresses.

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# EDITOR'S VIEW

I teach a class called "Plants and People;" as I explain to the students the first day, it's a course in ethnobotany, the study of the interrelationships between humans and the plant world. "Plants and People" is a catchier title which I like to think attracts a broader audience. It also reflects my approach to the topic—we read about real people and real plants; the students fan out across Columbia to talk to real people about real plants; ethnobotanical relationships hopefully emerge as we go.

In the process of choosing books for this class, I've had the pleasant task of reviewing dozens of ethnobotanies, old and new, from *Zuni Breadstuff* to *Nch'i—Wana, the Big River.* Many of the ones still in print now line my bookshelves. Choosing one ethnography to illustrate the breadth of plant/people interrelationships proved surprisingly difficult; from this anthropologist's point of view many authors dwell too much on individual plants and their uses, and not enough on how people think about plants, blend them into meals and medicines, and how people's relationship to the plant world changes through the seasons of the year and under the pressures of the changing world.

Have you found the perfect ethnography for teaching ethnobotany or ethnobiology? What about films or videos which take students into the realm of curing and the food quest? Send your suggestions, your class syllabae, and your thoughts on introducing students to our field to me by September 1993. We'll run a feature on this topic with the list of academic programs in ethnobiology requested by News and Comments editor Gary Martin. Send a description of your program to Gary or I by the same deadline.

Finally, I'd like to thank Chris Pulliam for his service to the *Journal* during my first 18 months as editor. Chris served as interim News and Comments editor and my editorial assistant; his help with bibliographic editing was much appreciated. Everyone here at the University of Missouri wishes him well in his new career.

—DMP

*J. Ethnobiol.* 12(2):161–185 Winter 1992

# ETHNOECOLOGY, BIODIVERSITY, AND MODERNIZATION IN ANDEAN POTATO AGRICULTURE

STEPHEN B. BRUSH
*Department of Applied Behavioral Sciences*
*University of California*
*Davis, CA 95616*

ABSTRACT.—Genetic erosion of traditional crops (landraces) has been predicted as a consequence of technological modernization and social change in centers of crop domestication and diversity. This paper discusses the impact of these changes on traditional potato diversity in the Andes of Peru. Comparative research between two valleys suggests that Andean farmers have maintained potato landraces, even as they adopt modern agricultural inputs. The emphasis on diversity in the ethnoecology of potatoes is explored as an explanation of this pattern. Consumption factors are particularly important in farmer conservation of biological diversity in potatoes.

RESUMEN.—La erosión genética de cultivos tradicionales (variedades criollas) had sido predicha como una consecuencia de la modernización tecnológica y el cambio social en los centros de domesticación y diversidad de plantas cultivadas. Este trabajo discute el impacto de estos cambios sobre la diversidad tradicional de papas en los Andes del Perú. La investigación comparativa entre dos valles sugiere que los campesinos andinos han mantenido las variedades criollas de la papa, aun al adoptar insumos agrícolas modernos. Se explora el énfasis sobre la diversidad en la etnoecología de las papas como una explicación de este patrón. Los factores relacionados con el consumo son particularmente importantes en la conservación de la diversidad biológica de las papas por parte de los campesinos.

RÉSUMÉ.—L'érosion génetique de cultures traditionnelles (espèces locales) a été considérée conséquence de la modernisation technologique et des changements sociaux dans les centres de domestication et de diversité de cultures. Cette note examine l'effet de ces changements sur la diversité des espèces locales de pommes de terre dans les Andes du Pérou. Une étude comparative entre deux vallés mettent en évidence que les paysans andins ont preservé les espèces locales meme si ils adoptent des varietés nouvelles. Les paysans soulignent l'importance de conserver la diversité des espèces locales. Les differents usages de la pomme de terre sont particulierement importants dans la conservation biologique.

Profusion of crop diversity has long been a puzzle, and in recent times it has become a conservation issue. De Candolle (1882) and subsequently Vavilov (1926) noted that interspecific and infraspecific variation of crop species is not evenly distributed, that hyperdiversity in the form of numerous locally named varieties or landraces occurs in certain areas, and that these areas are the most likely centers of crop domestication. Vavilov emphasized the importance of centers of diversity as pools of genetic resources for crop improvement. Many agricultural scien-

tists who are familiar with centers of crop diversity argue that the great profusion of species and genotypes is endangered by technical progress, social change, and environmental factors (Hawkes 1983). Yet, we have only a rudimentary understanding of how specific cultural traditions maintain and influence crop populations in centers of crop origin and evolution. Poor understanding of the ecology of crop diversity weakens our ability to assess the danger of genetic erosion and to plan effective conservation programs.

This paper questions whether the loss of biodiversity under conditions of agricultural modernization is as likely or widespread as purported. It examines the case of potatoes (*Solanum* spp.) in the Andes of Peru, the cradle of potato domestication and evolution. The paper begins with a general review of the ethnoecology of Andean potato agriculture. It then presents data on two Andean valleys that have different histories of agricultural modernization. It argues that diversity persists in peasant agriculture even after intensification and commercialization. While ecological and utilitarian factors are often cited as paramount in the maintenance of diversity (e.g., Clawson 1985), this paper concludes that these factors can only partially explain the practice of Andean farmers to conserve high levels of potato diversity.

One obstacle to understanding crop diversity has been that variation is at the infraspecific level. Burtt's advice on treating infraspecific variation is stark: "the best thing to do with a muck-heap is to leave it undisturbed so that it quietly rots down. In course of time the *Code of Nomenclature* will no doubt accept it as disposable refuse" (Burtt 1970:238). Bulmer (1970) notes that a similar aversion seems to prevail among ethnobiologists. Nevertheless, there are several good reasons for grappling with the ethnobiological treatment of plant varieties, especially of crops. The infraspecific level is common to many ethnobotanical systems (Atran 1987; Berlin 1976; Dougherty 1978), and elaborate varietal classification is conspicuous in some folk systems. Variety identification becomes more significant with industrialization and implementation of intellectual property rights. Perhaps most importantly, the variety level is a primary unit in the management of agricultural ecosystems by farmers around the world. Several case studies reveal the merits of drawing a more explicit connection between ethnobiology and farmer decision making in agriculture (e.g., Johnson 1974; Richards 1985). These studies reflect Bulmer's (1974) point that one of ethnobiology's principal goals is to understand how the determination of biological species relates humans to the biological dimension, a point that has been reiterated in the recent emphasis on "indigenous knowledge systems" (Brokensha et al. 1980).

## INTRODUCTION: ETHNOECOLOGY OF ANDEAN POTATOES

Bertonio's (1612) dictionary of the Aymara language mentions some of the many names applied to the vast diversity of potatoes found in the central Andes. Contemporary Andean farmers still use some of the same terms. While it is unlikely that the varieties currently grown are biologically the same as those grown 400 years ago, there is continuity in Andean ethnobiology. Many ethnobiologists and geneticists have come to believe that the biological diversity of Andean

farming systems is endangered by contemporary trends, particularly the diffusion of new potato varieties (Ochoa 1975). The loss of biodiversity threatens the continuity of Andean agriculture that has withstood the upheaval of European conquest and colonization.

Two dominant approaches stand out for understanding cultural adaptation by Andean people to their high mountain environment. One focuses on the indigenous knowledge of Andean people, especially the identification and use of local plants, animals, and production zones, emphasizing the diversity of biological resources that are used (Franquemont et al. 1990; Gade 1975; Tapia Núñez and Flores Ochoa 1984). The other approach, referred to here as the cultural ecology model, focuses on the social mechanisms that determine the management of a heterogeneous landscape and provision social units from the household to the state (Murra 1975). The cultural ecology model emphasizes complementarity as one of the organizing principles of Andean society. The complementarity principle refers to the control and use of ecologically distinct, spatially separated production zones by single ethnic groups. This idea was originally articulated by Murra (1975) as ''verticality.'' Thomas's (1973) work on energy flow showed that multiple zones were better able to provide sufficient energy than single zones, and Golte's (1980) research suggests that multiple zone use smooths out labor demand, thus making labor more efficient and productive than is possible within a single zone.

A prerequisite of complementary land use is an inventory of crops that are suited to the different physical conditions of the land: soils, temperatures, moisture, and evapotranspiration regimes. Describing the Vilcanota Valley of Peru, Gade (1975) found 36 species of Andean domesticates. The single most important Andean cultigen is the potato, and diversity within this crop in the Andes is greater than for any other crop grown there. Originally domesticated from tuber-bearing members of the Solanaceae family by Andean pastoralists, the potato has coevolved in the Andean environment for at least 6,000 years (Pickersgill and Heiser 1978). Potatoes are grown throughout most of the crop zones of the Andes, but they predominate in the upper zones, between 3,000 m and 4,000 m above sea level, and in some areas they provide up to 70% of the calories (Ferroni 1979). Eight different species and subspecies among four polyploid groups (diploid 2n=24 to pentaploid 5n=60) are cultivated. Some of these species (e.g., tetraploid, *Solanum tuberosum* subsp. *andigena)* are cosmopolitan, while others (e.g., *S. ajanhuiri)* are very localized in their distribution. Some 5,000 morphologically distinct varieties have been identified by the International Potato Center, out of more than 13,000 Andean accessions (Huamán 1986). Over 100 varieties may be found in a single valley and a dozen or more distinct varieties are kept by a typical farming household.

*Indigenous knowledge and diversity.*—Andean potato nomenclature was first described by LaBarre (1947) for the Aymara of Bolivia, and folk taxonomies have since been described for Quechua and Spanish speaking peasants of Peru (Brunel 1975; Brush et al. 1981; Zimmerer 1991a). Following LaBarre, recent descriptions of Andean folk classification find three or four taxonomic levels for potatoes: genus,

species, variety, and subvariety. Four criteria are important in potato classification: ecology (cultivated/wild/weedy; production zone), use (edible; for boiling; for freeze drying), plant and tuber phenotype, and degree of polytypy (number of subclasses). The similarities of potato nomenclature across languages and types of production systems are notable. Both terms and taxonomy found in contemporary nomenclature are also evident in Bertonio's (1612) Aymara dictionary. In both the seventeenth and twentieth centuries, Andean potato farmers distinguish potatoes by tuber phenotype, ecology, and use.

Table 1 presents a schematic diagram of a folk taxonomy of potatoes from the central and southern highlands of Peru. At the genus level, the *Solanum* tuber group ***(papa)*** is distinguished from other Andean tubers such as *Oxalis tuberosa* and *Tropaeolum tuberosum*. At the species level, domesticated, wild, and weedy types are demarcated ***(mikhuna papa, atoq papa, araq papa)***, and frost resistant, high altitude, bitter types ***(haya papa)*** with high glycoalkaloid content are differentiated from mid-altitude types without bitter compounds ***(miski papa)***. Table 2 compares the different folk species according to the four criteria mentioned above.

TABLE 1.—Schematic diagram of Andean taxonomy of potatoes (Cusco Quechua).

| Taxonomic Level | Term(s) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Genus | ***Papa*** | | | | | | | |
| Species | ***atoq papa*** | ***araq papa*** | | ***mikhuna papa*** | | ***haya papa*** | | |
| Variety | | | ***qompis*** | ***runtus*** | ***ruk'i*** | | ***waña*** | |
| Subvariety | ***alqa qompis*** | | ***yuraq qompis*** | | | | ***yuraq waña*** | ***yana waña*** |

Varieties are primarily distinguished according to tuber characteristics, such as tuber shape (oval, spherical, flat, long), the configuration of the tuber's "eyes" (depth, number, location, color), skin color and pattern (white to deep purple, solid color, multicolored), and flesh color and color pattern (solid, ringed, white to deep purple). In rare cases, nontuber characteristics such as stem or flower color distinguish varieties. Tuber characteristics are highly subject to somatic variation and to environmental influences. The relationship between tuber characteristics and plant genotype is not well understood.

The final level of Andean potato taxonomy is the subvariety, where the only contrast is between tuber colors. Black ***(yana)*** and white ***(yuraq)*** subvarieties are frequent, and variegated skin color is labeled ***alga***. Skin coloration varies continuously and is transitory in some varieties, and the subvariety label is often understood to be unstable. In other cases, however,subvarieties are stable and biologically distinct. ***Yuraq waña*** and ***yana waña*** are the two stable variants of a single species, *S.* x *curtilobum*.

TABLE 2.—Characteristics of folk species of Andean potatoes (Cusco Quechua).

| Folk Species | Ecology | Use | Phenotype | Polytypy |
|---|---|---|---|---|
| ***mikhuna papa*** | broad adaptability; mid-altitudes, 2,500–3,700 | boiling; soups; frying | nonbitter tubers; highly variable | very high |
| ***haya papa*** | frost resistant; high altitude, 3,700–4,100 | processing by freeze-drying; ***chuño*** | bitter tubers | low |
| ***araq papa*** | weedy species; low-medium altitudes, 2,500–3,200 | boiling; soups | nonbitter | low |
| ***atoq papa*** | wild species; all altitudes | not used | small tubers | none |

Potatoes in two lowest taxanomic levels are grouped into named categories that constitute intermediate ranking rather than separate taxa. Table 3 presents a description of six intermediate ranks that are common in the central Andes. These intermediate ranks are labeled and usually group several varieties and subvarieties by a single criterion, such as use or ecology. One grouping distinguishes potatoes with a high water content ***(uno papa*** or ***kal'wi papa)*** that are suitable for soups or frying from varieties with high dry matter ***(haku papa)*** that are preferred for boiling or steaming. Farmers also contrast modern potato varieties that have been introduced since 1950 with local or ''native'' varieties. Modern varieties (Spanish: *papa mejorada)* are light skinned, white fleshed, smooth, and generally larger than local varieties that are described as ***chalo. Chalo*** is used by both Quechua and Aymara speakers to describe mixed collections of potatoes with many colors and shapes. The word appears in Bertonio's (1612) Aymara dictionary ***(cchalu),*** suggesting that Andean farmers distinguished mixed collections long before the appearance of modern varieties.

The rich Andean nomenclature for potatoes is *prima facie* evidence for great diversity, and diversity at the species and infraspecific levels has been well documented for the Andes (e.g., Hawkes and Hjerting 1989). However, very little is known about the actual distribution of diversity either within or between regions or how diversity is affected by changes in agriculture. The measurement of genetic diversity and its distribution in Andean potato agriculture is confounded by the complexity within the group of cultivated *Solanums* and by the great number of phenotypes and genotypes at the variety level. Somatic variation, introgression between cultivated and wild species, and hybridization within cultivated

TABLE 3.—Intermediate folk categories at variety level in Andean potato classification (Cusco Quechua).

| Category | Distinguishing Criteria | Description | Contrast |
|---|---|---|---|
| ***wayk'u papa*** | use | dry/mealy potatoes for boiling or roasting | to ***unu papa*** |
| ***unu papa*** | use | watery potatoes for frying and soups | to ***wayk'u papa*** |
| ***k'usi papa*** | use | nonbitter tubers for freeze-drying ***(chuño)*** | to ***wayk'u papa*** |
| ***miska papa*** | ecology | fast growing; for short season ***(maway tarpuy)*** | to unnamed category for long season ***(hatun tarpuy)*** |
| ***chaqro/chalo*** | phenotype | mixed colors and shapes | to unnamed category for modern varieties (white potatoes) |

species also pose problems for measuring diversity. Geneticists who work with the crop have preferred to work at the ploidy or species levels rather than at the variety level (Hawkes and Hjerting 1989). However, recent advances in biochemical characterization of potatoes (Quiros et al. 1990) may help overcome some of the obstacles to biological assessment of diversity. These measures rely on isozymes, and they focus on characteristics that are far less variable or environmentally determined than plant descriptors such as tuber shape.

While varietal naming is a centerpiece of the Andean folk classification of potatoes geneticists have long believed that this system is not a reliable gauge of diversity for two reasons. First, the folk system is based on tuber characteristics that are only partially relevant to the biological systematics of the crop. Second, Andean farmers are believed to overclassify diversity (Hawkes 1947), a practice that is exemplified by the use of several names in a single community for a single type of potato and by the habit of changing names for such purposes as marketing. There is no evidence of a single, master list of names that farmers know or agree on, although they are aware of synonymy.

The individualistic, localized, and transitory nature of potato names would thus seem to limit them as a general tool for measuring diversity. Nevertheless, Quiros et al. (1990) found that there is a high degree of correspondence between farmer segregation and identification of tubers and biochemical (isozyme) profiles of tubers that reflect genotype differences. The isozyme analysis is particularly

relevant here, since one would not expect any degree of correspondence between a folk taxonomy largely based on one criterion (tuber characteristics) and biochemical identity based on characters that are invisible to Andean farmers. Households are the primary management unit of selection of potato varieties and the primary unit for maintaining diversity. Assessment of the amount of diversity kept by different households is therefor essential to an oveall understanding of diversity in the agricultural system, and this assessment can rely on farmer identification. Thus, research on diversity can draw directly on folk classification, as long as the unit of analysis is the household.

*Cultural ecology of potato agriculture.*—Isbell (1978) reports that households in Ayacucho, Peru, initially receive gifts of seed potatoes from the couple's parents, but afterwards they are generally on their own in selecting and maintaining varieties. This pattern pertains both north and south of the Ayacucho area. Additional varieties are acquired through trade, purchase, gifts, and wages in kind. Women play an especially important role in the identification and selection of varieties, and women are involved in every stage of potato production: seed selection, production, harvest, storage, processing, and cooking. The key role of women has been described in Ecuador (Weismantel 1988), Peru (Allen 1988), and Bolivia (Johnsson 1986). Men acknowledge women's superiority in plant knowledge and defer to them when questions arise about potato identification.

The Andean potato crop, both within villages and across regions, includes a few cosmopolitan varieties that are cultivated by virtually every household and many varieties that are cultivated by only a few households. Cosmopolitan varieties include ***huayro*** in central and southern Peru, ***qompis*** in southern Peru, and ***imilla*** in southern Peru and Bolivia. Approximately half of the total varieties in a household's inventory are these common varieties, but only a small percentage of a region's varieties are common (Zimmerer 1988). Common varieties include both native and modern ones that are kept for different purposes; the native ones because of their culinary and commercial value and the modern ones because of their yield and acceptance in the market. Improved and native commercial varieties are often grown as monocrops in single fields or blocks within fields, and they may account for 70–90% of the area planted in potatoes in many places (Mayer 1979). The prevalence of certain native and improved varieties means that most of the diversity can be kept in only a small portion of the farm, where modern and selected varieties are not grown. This pattern is facilitated by the fragmentation of Andean landscapes, by complementary land use by single households and villages, and by the practice of cultivating numerous fields in the same year.

The ethnographic literature provides strong evidence that consumption is critically important in maintaining diversity. Virtually every study of potato selection refers to the importance of subtle yet elaborate contrast in taste, color, and texture of Andean tubers (Johns 1990; Johnsson 1986). Carter and Mamani (1982) note that certain varieties are prized for special meals, the most favored also being the most delicate and least productive. Brush (1977) describes certain varieties that are saved for gifts. Johnsson's (1986) study in Bolivia discusses the importance of potatoes and potato diversity to the cultural identity of the Aymara.

His emphasis reflects Carter and Mamani's (1982:98) account of the Mauca family's pride and prestige in possessing seed of many rare potato varieties. The contribution of potato diversity to Andean identity and prestige is echoed by Weismantel's (1988) study of Zumbagua, Ecuador. Potatoes are not a primary staple for most Zumbaguan families, but they retain prestige. Serving meals without European introductions such as barley and fava beans is a privilege of more affluent families. This contradicts the popular and Eurocentric notion that potatoes are always judged to be inferior food to cereals.

Intuitive logic asserts that diversity also exists because it is adaptive, leading to more stable production in the face of great environmental heterogeneity and abundant pests and pathogens. Brush (1977) and Carter and Mamani (1982) report that farmers recognize specific agronomic characteristics in certain varieties, such as resistance to disease or insects. While diversity may endow an adaptive or ecological advantage to subsistence farmers without other means to control disease or limit the effects of poor weather, this advantage is not particularly evident in potato names at the variety level. One exception occurs within the bitter species ***(haya papa)*** where more frost resistant varieties ***(ruki,*** *Solanum juzepczuki)* are contrasted with less frost resistant varieties ***(waña,*** *S.* x *curtilobum).* However, within the nonbitter folk species ***(miski papa),*** where diversity is greatest, there are exceptionally few widely shared names that refer to tubers with special resistance to insects, disease, or poor weather.

It is possible that a more diverse collection of potatoes performs better than a less diverse one as it is moved over the heterogeneous landscape. However, this superior performance must ultimately be traced to the performance of specific varieties at certain places and under particular conditions. We might expect diversity to be retained because certain varieties perform best at certain locations that vary by soils, water availability, temperature, and so forth.

One-to-one relationships between particular varieties and environmental conditions, such as soils, insect predation, or disease, have rarely been reported or evaluated (Hawkes and Hjerting 1989). Strong resistance to disease, insects, and drought is rare in domesticated potatoes, although some resistance is found within the predominant subspecies of the Andean region *(Solanum tuberosum* subsp. *andigena)* (Hawkes and Hjerting 1989). While the ethnobiology of insects and crop diseases of the Andes has not been specifically studied, the observations of agronomists indicate that a folk classification of six insect species that attack potatoes exists (Universidad Nacional San Cristobal de Huamanga 1983). Plant disease taxonomy is the least developed of the folk systems. Andean farmers gloss several diseases under the Spanish term *rancha* (late blight), but they do not recognize several major pathogens, such as nematodes and viruses. Knowledge of soils has been documented (McCamant 1986), but no single matrix seems to exist that maps potato varieties onto soil types.

The widely practiced sectoral rotation of fields (Orlove and Godoy 1986) is especially problematic to an ecological interpretation of diversity. This practice results in the yearly movement of the potato crop between fields in different parts of the community's territory. If ecological advantage of potato diversity results from fitting genotype to location, then this advantage would seem to be eliminated by the practices of frequent field rotation and the practice of growing diverse

collections of potatoes together, instead of placing each variety in its special niche and keeping it there. Andean farmers do not emphasize site-specific adaptation in their nomenclature or management of potatoes, and agronomic trials suggest that most individual potato varieties perform equally well over a broad range of altitudes (Zimmerer 1991b). While the contrast at the folk species level between nonbitter, mid-altitude types ***(miska papa)*** and bitter, high altitude, types ***(haya papa)*** is salient on several axes (production zone, relative hardiness, processing, and consumption), the contrast between varieties is based primarily on tuber phenotype. Potato farmers report that the most diverse, native varieties are also the least resistant to disease, insects, and the effects of poor weather.

Diversity may have a very long-term advantage that is not specifically recognized in Andean folk biology or immediately apparent in the short-term. Long-term stability of potato production may be enhanced by having a large repertoire of genotypes, some of which have particular advantage as environmental conditions, pests, and pathogens change over time. Under different conditions, varieties that are now rare may become advantageous, and thus prevalent. A large repertoire may seem superfluous in the short run, but it allows farmers to adjust to new conditions, including market demand.

*Loss of diversity.*—Andean agriculture has never been a static system, and cultivators have long been able to accommodate new technology such as European crops and animals. However, the pace of change appears to have accelerated during this century. Market penetration, migration, population growth, political reform, and new technology are now ubiquitous. Integration of local communities into larger political and economic systems has been present since pre-Hispanic times, but this integration has changed both qualitatively and quantitatively in the twentieth century, with the spread of capitalism, through increased population, and the expansion of state power, roads, and mass communication. The Peruvian population almost tripled between 1950 and 1990, from 7.6 million to 21.9 million (Urban and Trueblood 1990). Rural areas have experienced far less growth because of emigration to urban areas, but demographic pressures are felt everywhere, as market systems have expanded and rural hinterlands have been more closely incorporated into national economics. The presence of centralized state power has increased through means such as agrarian reform, education, and regional development. Andean production is now characterized as much by commoditization and the acquisition of new technology as by complementarity and community regulation. Virtually every household now uses not only some Old World crops and animals but also agricultural chemicals and improved Andean crop varieties.

Modern potato varieties were first released in Peru in the early 1950s, and they are now found in virtually every village in the highlands. These varieties were specifically bred to be higher yielding, better able to utilize fertilizer, and resistant to specific stresses such as disease or drought. Their adoption is directly encouraged by agricultural extension and credit policies of the government and indirectly by such factors as population increase or a farmer's wish to produce a larger surplus for the market. Two impacts of the diffusion of modern crop

varieties in the Andes have been reported: increased productivity (Horton 1984) and loss of potato diversity (Ochoa 1975).

The concept of genetic erosion in farming systems is based on somewhat simplistic biogeography. Adopting modern crop varieties decreases the area that is planted to the traditional and more diverse varieties. Shrinking the area devoted to native crops should logically reduce diversity, just as the size of islands is directly related to biological diversity (McArthur and Wilson 1967). The basic flaw with this logic is that it assumes that farmer behavior towards traditional crops remains unchanged as improved crops are adopted. The biogeographic view of genetic erosion does not account for cultural, economic, and environmental buffers in agricultural systems that might protect diversity. Environmental heterogeneity, agronomic risk limit, market factors, and cultural factors are likely to limit the substitution of one or two varieties for the dozens that have evolved locally. The remainder of this paper will examine whether this conservation has occurred in Andean potato agriculture in two highland valleys of Peru.

## METHODS

The impact on traditional crop diversity of the adoption of new varieties and agricultural intensification should ideally be studied in a historic framework by following the fate of diverse native crops as these changes occur over time. By all accounts, modern potatoes spread rapidly throughout the highlands after 1950. Unfortunately, we have neither biological nor socio-economic benchmarks from a period before the diffusion of these varieties. The oldest systematic and preserved collections of native potatoes date only to the early 1970s, and our information on agricultural practices before 1950 is scanty and superficial. Without these historic benchmarks, comparison among regions, villages, and households is a valuable way to estimate the impact on diversity of such factors as commercialization of agriculture or the adoption of modern potato varieties. With this comparison in mind, research was undertaken in two valleys in eastern Peru. These valleys were chosen both because of their similarities and differences.

*Study sites.*—Reconnaissance in 1978 indicated that studying valleys in Peru's central and southern highlands would provide contrasting records of agricultural modernization and commercialization. Peasant villages in the central highlands were known to have a longer record of the adoption of modern technology and greater integration into regional and national commercial networks. Reconnaissance in 1978 and 1984 suggested that the Tulumayo Valley, 50 km east of Huancayo in central Peru, was representative of areas with records of great potato diversity that had undergone extensive modernization and commercialization. Paucartambo Valley, 50 km east of Cusco in southern Peru, was representative of diverse farming systems that had experienced less modernization and commercialization. The Tulumayo and Paucartambo valleys are like many others along the eastern Andean escarpment. They share the traditions of complementary land use and community control mentioned above. Rolling upland pastures descend into steep and narrow valleys where crops are produced on slopes that have been landscaped into terrace-like fields by generations of farmers. In each valley, "pea-

sant communities,'' or corporate villages, control agro-pastoral production over a large altitude range with different production zones. Each valley has some communities that existed independently and others that were part of *haciendas* before the agrarian reform of 1969-1970. The community provides the modern framework of complementary land use, but households make most of the in-field decisions, such as which crop and variety to plant. Production is destined both for home consumption and for the market, and each valley is located four hours by all-weather road from a major urban center, Huancayo or Cusco.

The Tulumayo and Paucartambo valleys are also alike in their emphasis on potato production and in the organization of potato production. Potatoes are the predominant crop, accounting for 54% of the cultivated land in Tulumayo and 47% in Paucartambo. In both valleys, households cultivate numerous small plots across production zones that are differentiated according to altitude, crops, agricultural calendar, intensity of land use, and degree of community control. Each valley produces both bitter and nonbitter varieties; each divides mid-altitude production into a lower, short cycle ***(maway tarpuy)*** and a higher, long cycle ***(hatun tarpuy);*** each relies on sectoral fallow and the simultaneous cultivation of different plots by the same household. Finally, both the Tulumayo and the Paucartambo valleys share regional fame as places where particularly high levels of diversity are found. These two valleys show a pattern that is familiar to agricultural systems in cradle areas of crop evolution and diversity. Small islands of traditional agriculture remain in a sea of more uniform, commercial agriculture based on the use of modern crop varieties and high energy inputs.

The major differences between the two valleys have to do with ethnicity, degree of commercialization of potato agriculture, and the history of adoption of modern potato varieties. A generation ago, the people of the Tulumayo were Quechua speakers, but today Spanish is the most widely spoken language. Labor migration from this valley to the mining industry in central Peru has been a significant force in shaping local cultural identity during this century (Long and Roberts 1984; Mallon 1983). Tulumayo people identify themselves as *mestizos*, and they are explicit about the cultural differences between themselves and Quechua-speaking people who live south of the Mantaro Valley. Quechua is the predominant language of Paucartambo, where ethnic identity is Indian (Allen 1988). Paucartambo has not experienced such a singular integrating force as massive labor migration to mines. Its integration into the regional economy of southern Peru has been through the *hacienda* system and through periodic migration to Cusco and to commercial farms in the lowlands. This integration has not produced the fundamental shift in ethnic identity experienced in the central highlands. Differences in potato agriculture between the two valleys can be seen by comparing three types of potatoes: improved varieties, native commercial varieties, and mixed native varieties. These types are salient to the farmers in the study in terms of classification and management.

*Sample and survey strategies.*—The object of studying the Tulumayo and Paucartambo valleys was to model the impact on traditional potato diversity of the adoption of improved potato varieties by comparing households and valleys. The Tulumayo and Paucartambo valleys are each heterogeneous in similar ways.

Different production systems are distributed according to altitude, and these vary by agricultural intensity, community control, crop, and crop variety. Different areas in each valley are more readily accessible to the principal town, the local nexus between peasant communities and regional market and administrative systems. We assumed that better access to the principal town lowered transportation costs and made more available modern technological inputs, including information and new potato varieties. The complexity of potato agriculture in the Andes, heterogeneity within each valley, and differences between valleys were issues in determining a research design. These issues were addressed by surveying in several villages within each valley, by sampling a reasonably large number of households, and by focusing on three categories of potato varieties: improved, native commercial, and mixed native.

The first step in surveying was to select villages for sampling, and this was done by reconnaissance in November 1984. Potato producing villages were selected using two criteria: altitude and distance (travel time) to each valley's administrative center. Villages were chosen in each valley at three altitudes: high (village at $>$3,500 m), middle (village at 3,000–3,500 m), and low (village at $<$3,000 m). The distances from the administrative center varied by the existence and quality of roads. In the Tulumayo Valley, 14 villages were surveyed. The closest of these to Comas, the economic and administrative center of the Tulumayo Valley, was 30 minutes by car, and the most distant was three hours over a road that had opened in 1984, the year our fieldwork began. In Paucartambo, 10 villages were surveyed. The closest to the town of Paucartambo was 30 minutes by car, and the most distant was four hours by foot.

The researchers contacted the elected officials of each village or peasant community to explain the research, obtain permission, and select the sample. Peasant communities in Peru keep membership lists of their inhabitants. A short questionnaire was prepared to gather information from the elected officials about the village inhabitants, using the membership list as the base. The village officials were asked to estimate age of the household head, marital status, family size, educational background, extent of land holdings, off farm employment, and socio-economic status of each member of the community. This information was then used to select a sample of households for the main survey. The objective was to include households of different socio-economic status in a survey of between 15 and 20 households in each village. A total of 154 surveys were conducted in the Tulumayo Valley and 204 in Paucartambo.

The main survey instrument was applied between January and July, 1985, in the Tulumayo Valley and between January and September, 1986, in the Paucartambo Valley. The survey instrument included questions on household characteristics and farming practices and the use of the production from each cultivated parcel. Questions about fallow land were also asked. We gathered information about each of the three general types of potatoes, improved, native commercial, and mixed native, such as how seed was acquired and how often, and advantages and disadvantages of the types. Finally, an inventory of varieties was made by drawing a random lot of 100 tubers from the potatoes stored in the farmer's house. These tubers were then sorted by the farmer into varieties that he recognized, and three to six tubers of each variety were requested for analysis

and conservation in the collections of the International Potato Center and the University of Cusco. In the early stages of interviewing, it became apparent that we would not be able to conduct an inventory of the entire sample of households that were being surveyed, because of difficulties of logistics and gaining access to the farm's store of potatoes. Our solution was to revisit a smaller number of households that were chosen randomly from the larger sample after completion of the survey. In the Tulumayo Valley we obtained inventories from 87 households, and in Paucartambu we completed 85 inventories.

The survey took approximately one and a half hours to complete. A survey team of five interviewers was employed in each valley. One surveyor worked in both valleys. The surveyors had university training in anthropology, economics, and agronomy. More than half of each team had previous fieldwork and survey experience. Team members lived in villages for one to three months while conducting the survey. Besides the survey on potato varieties and farming practices, the surveyors made ethnographic notes on each of the households that they surveyed. In addition to the variety survey, the research team also produced a land use map of each valley and completed a detailed study of the economics of peasant potato agriculture (Mayer and Glave 1990).

A principal object of the survey on potato varieties was to compare the extent and treatment of three different types of potatoes, improved, native commercial, and mixed native. Improved potatoes are bred for their adaptability to a wide range of Andean environments. They are planted in both of the production zones for nonbitter potatoes, although they are more common in the lower one ***(maway tarpuy)***. They are usually smooth and white skinned and somewhat higher in water content than native potatoes. Improved varieties are especially important for commercial production, and they represent a large proportion of all potatoes sold (78% in Tulumayo and 62% in Paucartambo). The native commercial varieties are local varieties that have been intensively selected and are grown in monocultures for the market. They are regarded as excellent eating potatoes by farmers and urban consumers alike. They have moderately deep eyes, colored skin, and cream colored flesh with a high percentage dry matter. These are varieties that are grown by virtually every household. They are well known to merchants and urban consumers, and commercial demand has led farmers to plant them in uniform fields that are managed much like fields of improved varieties. Mixed native varieties are the prime source of diversity in Andean potatoes. Their tubers are usually small and come in many shapes and colors, inside and out, a characteristic that is captured in the label ***chalo***. These mixed native varieties have tubers with many different degrees of dryness and different flavors. They are planted as random collections in the high zone ***(hatun tarpuy)***. Production from mixed native collections is sold, but they are not subject to the same selection pressures as the specifically commercial varieties. These collections are planted by almost every household in the two valleys but in only a small portion of the total land of Tulumayo farms.

## RESULTS AND DISCUSSION

Comparison between the two valleys and among the three types of potatoes reveals a number of predictable contrasts but some intriguing surprises. Table 4

TABLE 4.—Potato distribution in the Tulumayo and Paucartambo valleys. Values are percentages of potato types by zone.

| | Tulumayo Valley (n = 154) | | | Paucartambo Valley (n = 204) | | |
|---|---|---|---|---|---|---|
| | Improved | Native Commer. | Native Mixed | Improved | Native Commer. | Native Mixed |
| *Hatun Tarpuy* (Long Season Zone) ..... | 23 | 75 | 89 | 28 | 10 | 98 |
| *Maway Tarpuy* (Short Season Zones) ..... | 77 | 25 | 11 | 72 | 90 | 2 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

shows the distribution of different potato types according to the weight of seed reported by farmers in the survey. The important contrast here is between improved and mixed types in the two production zones. Predictably, improved varieties are grown primarily in the lower zones that are farmed more intensively throughout the central Andes for commercial purposes (e.g., Mayer and Fonseca 1979). Native types, especially mixed varieties, are concentrated in the high zone where agriculture is less intensive and community control more direct. Another striking contrast between the two valleys is the location of native commercial varieties. In the Tulumayo Valley, these are primarily grown in the high zone ***(hatun tarpuy)*** while in Paucartambo, they are grown mostly in the lower zone ***(maway tarpuy)***. In both valleys, the lower zone is dedicated to commercial production of the high-yielding improved and high-value native commercial varieties, to take advantage of high off-season prices. The difference in location of native commercial varieties reflects the fact that Paucartambo farmers plant another commercial crop, barley, in the upper zone. Native commercial types are less important in Paucartambo than in Tulumayo.

Table 5 presents data on the percentage of potato area planted in the three types and the use of the entire potato crop for sale and consumption for each valley. These figures refer to the total seed planted and harvest weight of potatoes as estimated by farmers. Eighty-nine percent of the Tulumayo Valley's potato area is planted to the more commercial types, in comparison to only 39% of the Paucartambo Valley. This contrast suggests that potato production in the Tulumayo Valley is more commercially specialized. Improved types comprise the bulk of potatoes that are sold in each valley. In Paucartambo the consumption of mixed native potatoes is considerably higher, reflecting their greater area there than in Tulumayo.

Table 6 presents data on potato use (sale, consumed, saved for seed) of each of the three types of potatoes. The data in Table 6 show that improved potatoes

TABLE 5.—Potato farming systems in Tulumayo and Paucartambo valleys. Values are percentages of potato types.

| | Tulumayo Valley (n = 154) | | | | Paucartambo Valley (n = 204) | | | |
|---|---|---|---|---|---|---|---|---|
| | Improved | Native Commer. | Native Mixed | Total | Improved | Native Commer. | Native Mixed | Total |
| Area in potatoes | 59 | 30 | 11 | 100 | 31 | 8 | 61 | 100 |
| Percentage of potatoes sold | 78 | 20 | 2 | 100 | 62 | 7 | 31 | 100 |
| Percentage of potatoes consumed | 41 | 37 | 22 | 100 | 30 | 8 | 62 | 100 |

are primarily grown for sale in both valleys, but the data also reveal that relatively high percentages of the mixed native varieties are also sold. The data presented in Tables 4–6 suggest that variation in use is continuous rather than discrete. Farmers in both valleys grow different varieties and mixes of varieties in separate fields, but the production from all fields is used for both consumption and sale. Comparing Tables 5 and 6 indicates that no simple division can be made between production for sale of improved potatoes versus production for use of mixed native potatoes. The consumption of native potatoes is higher in Paucartambo, but so is their sale, since modern potatoes represent a smaller proportion of all potatoes produced.

The variation of diversity, management level, and commercialization between fields of different varieties and combinations of varieties is continuous. Tulumayo and Paucartambo farmers do not create, conceive of, or manage fields according to a matrix of discrete types: low input or high input, commercial or subsistence.

TABLE 6.—Potato use by type in Tulumayo and Paucartambo valleys. Values are percentages of potato types.

| | Tulumayo Valley (n = 154) | | | Paucartambo Valley (n = 204) | | |
|---|---|---|---|---|---|---|
| | Improved | Native Commer. | Native Mixed | Improved | Native Commer. | Native Mixed |
| Percentage sold | 80 | 62 | 45 | 64 | 50 | 25 |
| Percentage consumed | 9 | 26 | 43 | 20 | 39 | 55 |
| Percentage saved for seed | 11 | 12 | 12 | 16 | 11 | 20 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

The continuous gradation of management, selection, and use allows ample opportunity for different mixes of local and outside inputs, enabling the conservation of traditional varieties and production technology throughout the system.

*Keeping diversity.*—The social framework of Andean agriculture is experiencing fundamental changes: incorporation of local communities into larger regional systems (especially markets), demographic growth, development of economic and technological infrastructure, and political and social restructuring of Andean society through land reform. It has been common to assume that such changes will bring about the rapid decline of diversity, as "traditional" agriculture is replaced by a "modern" system (Hawkes 1983).

Improved potatoes came into the Tulumayo Valley almost as soon as they were released in 1950, but they did not appear in Paucartambo until 1960. Tulumayo farmers average almost twice as many years as their Paucartambo counterparts in producing these varieties (Table 7), and this longer period of adoption is reflected in the higher percentage of potato area in the Tulumayo Valley that is planted with improved varieties. Tulumayo suggests a glimpse of the path of agricultural change that Paucartambo may follow, as measured by agricultural

TABLE 7.—Technology adoption and potato diversity.

| | Tulumayo Valley | Paucartambo Valley |
|---|---|---|
| Average number years using improved varieties[1] | 13.9 | 7.8 |
| Year of first introduction of improved varieties[1] | 1950 | 1960 |
| Percentage of farmers who have ever planted improved varieties[2] | 95.8 | 79.0 |
| Cumulative number of improved varieties planted since introduction[2] | 16 | 7 |
| Percentage of farms using purchased fertilizer[2] | 97.9 | 85.8 |
| Percentage of farms using pesticides[2] | 95.7 | 77.2 |
| Average number of native varieties per farm[1] | 12.8 | 9.6 |

[1]n = 87 for Tulumayo and 85 for Paucartambo

[2]n = 154 for Tulumayo and 204 for Paucartambo

intensification, commercialization, and adoption of new technology. If we accept the model that the diversity of traditional crops will be adversely affected by the increased use of modern technology—in particular, seed varieties and increased integration into the market—then a comparison between the two valleys may give us some idea about the fate of native potatoes.

On a biogeographical basis, we may expect crop diversity to decrease as commercial and more intensive agriculture relying on modern potato varieties takes hold over a larger and larger portion of the two valleys. Table 5 showed that fields of mixed native varieties represented only 11% of the Tulumayo's potato area. These fields are small islands of diversity, surrounded by biologically more uniform fields. The size of these islands of traditional, mixed potatoes is critical to conserving diversity. In Paucartambo, mixed native fields comprise 61% of the potato area. Biogeographically, we should thus expect Tulumayo to have much less diversity than the southern valley. In fact, the average number of varieties per household in the Tulumayo Valley is 12.8, compared to 9.6 varieties per household in Paucartambo. Table 7 sets this comparison in the context of adoption of improved varieties, illustrating the idea that the farmers of Paucartambo are at an earlier stage in the adoption process of improved potato varieties. It also suggests that diversity of native potatoes remains, even after adoption becomes virtually complete, as long as some area is planted to native potatoes.

Tulumayo's higher average number of potato varieties per household may result from its history of having greater diversity than Paucartambo before the introduction of modern varieties. However, the southern valley is regarded by most potato biologists to be within the region of greatest diversity in Peru (Hawkes 1983). Nevertheless, Tulumayo's higher average underlines the point that modernization has not eliminated diversity. Statistical modeling indicates that the loss of diversity resulting from technology adoption may be asymptotic after an initial period of genetic erosion (Brush et al. 1992). The loss of diversity is neither simply described nor linear. Social reproduction in the Andes is best understood as a syncretic process whereby local and exogenous elements are continually combined (Allen 1988). Likewise, agricultural change in the Andes is not a dichotomous process of the replacement of older technology, but one whereby indigenous and imported technologies are combined into a single mosaic. Thus, fields of modern potato varieties are managed within the sectoral fallow system, and fields of mixed native potato varieties are rotated with European crops, e.g., barley and fava beans. Potato production in these two Andean valleys is not a dual system of production for use with native technology and production for sale with modern technology. Virtually every potato field has elements of indigenous and outside technology, and production of all types of potatoes is used both for consumption and for sale.

Table 8 outlines the major reasons that favor and discourage native and improved potatoes in relation to three factors: consumption, commercialization, and production. This table suggests the complexity of determining the advantages and disadvantages of producing either type. It also shows that there is no single axis on which to select the two types. Cultural identity, culinary quality, risk, yield, and commercial demand interact in the decision. Andean farmers are

accustomed to wrestling with complexity of this nature, and they long ago learned that production and use decisions are not simple dichotomies.

TABLE 8.—Selection criteria for native and improved potato varieties.

| | Factors Favoring Selection | | Factors Discouraging Selection | |
|---|---|---|---|---|
| | Native Varieties | Improved Varieties | Native Varieties | Improved Varieties |
| Consumption factors | good tasting; valued for gifts | lower unit cost | higher unit costs | inferior taste; less suitable for usual cuisine; larger tubers require more fuel |
| Commercial factors | higher market value; high exchange value | more profitable (good benefit/ cost ratio) | low yield under traditional management | low market value; limited local market |
| Production factors | don't need new seed; seed readily available | good short-term resistance to specific risks | less resistance to specific risks | new seed required |

Native potatoes are universally acknowledged to be culinarily superior to modern varieties. The first measure for judging taste in both valleys is how a particular variety tastes when cooked in the ***watia***, a simple oven constructed of rocks or sod in the field at harvest time. Varieties are also evaluated by how well they taste after boiling or steaming. Give the problems of synonymy, agreement among people on the identity of different tubers, and individual taste differences, no single native variety represents a culinary standard for other potato varieties. The varieties that come closest to this status are the cosmopolitan, native commercial ones that are found in virtually every household, such as ***huayro*** in the central highlands and ***qompis*** in the south. However, I have been frequently told by informants that rare native varieties are equal or superior to these commercial native varieties.

Native potatoes are preferred as a class because they are drier than the improved varieties, which are thought of as insipid and watery ***(uno papa)*** and suitable for frying or for soups but not for standard boiling. Ritual meals and celebrations and meals for guests emphasize native potatoes. Weismantel (1988) writes that potatoes occupy a primary place in the system of culinary signs and metaphors that comprise Quichua identity in Ecuador. She observes that "White" guests are served meals in which potatoes are minor complements to chicken and rice, while "Indian" guests are served guinea pig and potatoes. Native varieties

are favored gift items and are used to strengthen social ties, and some reports refer to them as "gift potatoes" (Spanish: *papas de regalo)* (Mayer 1979). Native potatoes are often expected as part of wages and during reciprocal labor exchange when meals are served. In the extremely tight labor market of Andean agriculture, the offer of ***wayk'u papa*** as partial payment is a good way to guarantee a supply of workers at critical times. These potatoes likewise are attractive to distant trading partners who bring meat and wool from the *puna* to exchange for potatoes. There is large and active market for all varieties of potatoes between the two valleys and the regional urban and commercial centers, but the internal market for potatoes within the valleys is small and not well developed. Individual households do not trade, barter, or sell significant amounts of potatoes with their neighbors. Farmers speak of the desire to be self sufficient in the different kinds of potatoes. Thus keeping mixed native potatoes is seen as an option that is preferable to specializing in one type and relying on a market to supply mixed types.

While judged to be culinarily superior, native varieties are perceived as agronomically inferior to the modern ones. Native varieties are lower yielding and more susceptible to the major diseases and environmental risks affecting potato production. Table 4 showed that in both the Tulumayo and Paucartambo valleys improved potatoes are concentrated in the lower, ***maway*** zone. This zone is less subject to frost than the higher zone, but it is more susceptible to some of the most severe threats in Andean potato production: aphids, viruses, drought, and especially late blight *(Phythphtora infestans)*. Zimmerer (1988) points out that modern potato varieties have completely eliminated native varieties in the lower zones of the Paucartambo Valley.

Modern potato varieties depend on regular supplies of fresh seed tubers, since farmers change the seed for these varieties after two or three years. The seed for native varieties is kept for many years, and it is renewed by rotation between fields at different altitudes. Seventy-two percent of the Tulumayo farmers and 79% of the Paucartambo farmers in the sample reported that they never changed native potato seed. Sixteen percent of Tulumayo farmers and 49% of Paucartambo farmers said they never changed improved potato seed. Large farms that are more commercial or farmers with more capital may thus be more able to plant modern varieties than capital-poor farmers. On the other hand, native potatoes are marketed at premium prices, and a household may broaden its economic strategy by producing them for market. This is evident in the large percentage of land devoted to native commercial varieties in each valley.

While Table 8 and the preceding discussion explain the persistence of native potatoes, the question "why so much diversity" remains unanswered. This puzzle cannot be cracked by direct inquiry, because the question "why do you grow so many types of potatoes?" is a silly and nonsensical question to Andean farmers. Informants were surprised and baffled by the question. From their point of view, diversity is natural and a given of the Andean ecosystem, rather than something strange or unusual to be explained. They manage one of the most heterogeneous and complex agroecosystems in the world, and diversity within a single crop and within a single field is a logical corollary of the variety of the world around them. From this perspective, the question of diversity may only be asked indirectly by

examining why farmers don't eliminate diversity in favor of a single type of potato, improved or native. This question is less absurd to Andean farmers, but it asks them to speculate about something which they don't usually do.

Farmers in the Tulumayo and Paucartambo valleys have not eliminated diversity because they don't perceive any advantage to doing it and because there are advantages to keeping their mixed collections of native potatoes. Improved varieties don't taste very good, so they are not likely candidates to replace native varieties, and no single native variety meets everyone's criteria for best taste or best for exchange, gifts, or sale. Diversity is a pleasure in its own right when sitting down before a bowl of potatoes as the primary food at a meal. It is common for people to eat 20 to 30 potatoes at a single meal, and it is much more interesting if every other potato is a different variety. Diversity is akin to a condiment, like hot peppers, making meals more interesting. Naming often provides for word games that enliven meals. Some names are clearly evoked by the tuber's characteristics: pink, flat, and oval (cow's tongue, ***wacapahallum),*** cylindrical with eyes clustered at one end (cat's nose, ***mishpasingu),*** or a mottled, rounded oval (condor egg, ***condor runtu).*** Other names evoke places, perhaps where the variety originated (e.g., ***Curimarca).*** This nomenclature is rich in Andean wit, irony, and iconoclasm. We find such folk varieties as "priest's ear" ***(kurapalingling)***, as seen through the confessional screen; another is "dog's vomit" or "dog's stomach" ***(alcapapanzan)*** in Quechua, glossed to "Peruvian flag" in Spanish.

When queried about replacing mixed native varieties with improved, higher yielding ones or selected native types, farmers point to two things that encourage diversity. First, there is no need to make such a simplifying replacement in the diverse Andean landscape. They cultivate potatoes in several fields each year, and in an Andean variant of agricultural involution, they always find space and time for a few native potatoes. Farmers of the Tulumayo valley have reduced this to a very small portion of their fields, but they maintain a high amount of diversity on this small portion. Enough potatoes are produced to satisfy local needs, and the market is often saturated with potatoes during the main harvest. They complain that they lose money on the potatoes that they do sell (Mayer and Glave 1990). Thus there is no incentive to squeeze out the small fields of native potatoes for food or commerce.

Second, the collections of mixed native potatoes are perceived as a resource by farmers who are economically marginalized. Mixed native potatoes are associated with traditional Andean agriculture and culture by subsistence and commercial farmers, by Quechua and *mestizo* farmers, and by urban consumers. Native potatoes are grown in the most marginal of areas by marginalized farmers. Like other material elements of Andean culture, such as weaving, their value has been inverted in the Andean kaleidoscope (Isabell 1978), that at once depreciates and values items of traditional culture. Products of a humiliated group, native potatoes command premium prices in regional markets, such as Cusco and Huancayo, where they have been elevated to the status of an artisan crop. Within farming communities, native potatoes are also appreciated, perhaps as much for their cultural significance as for their superior flavor. They are favored gift items,

and in a rural economy that is increasingly short of labor, they are used as added incentives by landowners to attract workers.

Wholesale merchants who purchase native potatoes have a narrow concept of diversity and prefer the one or two varieties that have won widespread appeal and recognition. However, the flow of diverse native potatoes to urban markets is sufficient to bring new native varieties to the attention of consumers and merchants alike. Periodic ''booms'' in demand for specific varieties are sufficiently common to be an incentive for farmers to keep diversity as a source of seed. The spread of the ***huayro*** variety from the central highlands to the Cusco region and the local appearance of ***olones*** (Franquemont et al. 1990) fit this pattern. The difficulty in multiplying seed rapidly and ambiguity in folk taxonomy are reasons farmers prefer to keep their own inventory of varieties rather than relying on exchange or the market place.

## CONCLUSION

This paper has explored the persistence of diversity in Andean potato agriculture. The ethnobiology of the potato crop emphasizes diversity at the infraspecific or variety level. Andean categories such as production zones ***(maway tarpuy*** and ***hatun tarpuy)*** and types of potato (dry, ***miski papa***; watery, ***uno papa***; boiling, ***wayk'u papa)*** all contribute to this emphasis. This case study is representative of several others on the maintenance of traditional crops in centers of agricultural origins in the face of economic and technological change in agriculture (Boster 1985; Brush et al. 1988; Dennis 1987; Richards 1985). These studies document the resilience of traditional crops, like the cultures that have produced and nurtured them.

We might imagine two alternative futures for traditional Andean potatoes from the above analysis. On the one hand, there might be a gradual encroachment of improved and uniform native varieties under the inexorable pressures of population growth and incorporation into regional market systems. The impact of this encroachment is to shrink the area devoted to mixed native varieties, and this impact is evident in the comparison between the Tulumayo and Paucartambo valleys. The small area of mixed native potatoes with its tremendous diversity may be the last remnant of a waning agricultural system, whose replacement is already present. Ultimately, the area of native potatoes might shrink to nothing, thus completing the biological transformation of Andean agriculture that began with the European conquest 500 years ago. On the other hand, the continued presence of traditional potato area and diversity may be interpreted as biological evidence of the tenacity of Andean cultural elements in the technological polyculture that has existed since the European conquest.

Assuming that market incorporation, demographic growth, and technological innovation will continue and increase, the replacement hypothesis is plausible. However, the persistence of diversity in the Tulumayo Valley, at even a higher level per household than in Paucartambo, suggests that the Andean tradition of diversity will survive. The disappearance of traditional crops and of diversity has been predicted by theorists of very different persuasions (e.g., Hawkes 1983;

Fowler and Mooney 1990). Like the predicted demise of peasants, the eclipse of diversity is confounded by the complexity of the tropical world and by the actions of the inheritors of ancient farming traditions. Maintaining crop diversity echoes the survival of Latin American peasantry in the face of major structural change (de Janvry et al. 1989). Many factors dampen the predicted erosion of traditional potatoes in the two valleys described here. While the pressures of the adoption of modern varieties, market penetration, and population increase are significant, so too are cultural, economic, and environmental factors that buffer their impact. There is no single axis on which to chart the fate of these genetic resources as farming systems change. What seems to be predictable is that farmers will continue to be active agents in conserving the material base of their Andean agricultural legacy.

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# BOOK REVIEW

**Plants for People.** Anna Lewington. New York: Oxford University Press, 1990. Pp. vii, 232. $40.00 (hardbound). ISBN 0–19–520840–4.

With the welcome proliferation of economic botany courses in junior colleges and extension courses, there is a need for nontechnical books. *Plants for People* in many ways answers this need. With its friendly, conversational language its presentation succeeds in reaching the nontechnical reader yet it offers reliable data necessary for a broad understanding of people's dependence upon useful plants. There is, in addition, much material that frequently will be of value to the trained botanist who undertakes to teach economic botany but whose specialties in the plant sciences may be unrelated to mankind's utilitarian interests in the world's vegetation.

The book is organized into seven sections:

1. Starting the Day (soaps and cosmetics in general). An interesting technique is seen in the discussion of cosmetic color: a cosmetician painting a girl's lips on one page and a South American Indian whose face is completely painted with achiote on the next page. This kind of fascinating comparative illustrative presentation is common in the book and is used very effectively.
2. Keeping Us Covered. This section concerns primarily fiber, dyeing and printing, and various parts of clothing.
3. From First Foods to Fast Foods discusses an interesting variety of material which can be taken into the stomach, from our major food plants to Amazonian cow trees, coffee and tea, plant foods for different peoples (rain forest and desert dwellers), and ending with future foods.
4. House and Home—Plants that Protect Us. This section concerns various wood, thatch, rattan and sundry stems for furniture and wickerware, linoleum, bamboo, and even plant materials used in rain forest dwellings.
5. Your Very Good Health—Plants that Cure Us treats many species valuable for a wide spectrum of ills and discusses plants from the family medicine chest, medicines in the hospital, and the rain forest pharmacy.
6. Getting Around—Plants that Transport Us spans a broad consideration from rubber in its numerous uses, tree trunks and reeds for boats and canoes, construction of docks, and plants for future fuel.
7. Recreation—Plants that Entertain Us includes paper for words and pictures, papyrus, wood pulp, plants for inks and dyes, the camera and plants, and plants in musical instruments.

This list is far from a complete enumeration of the incredible types of employment that the Plant Kingdom offers and that are discussed in these seven sec-

tions. One very interesting section that might well have been added is Plants in Religion—the psychoactive species used in traditional societies in many regions and which are considered to be sacred or semisacred, a very significant aspect of aboriginal culture.

Another outstanding feature that makes this volume a special value in teaching is the ingenious selection of illustrations, all in color, that span from the purely botanical to people, products, methods, and instruments of use, temperate woodlands, tropical rain forests, agricultural fields, and many other aspects of plants and their value to mankind.

There is a comprehensive index followed by author's acknowledgements and picture credits.

I must congratulate the author for her ingenuity and originality and the Oxford University Press for such a beautiful publication. It is indeed going to be a success as well as a stimulus to the teaching of economic botany.

Richard Evans Schultes
Director Emeritus
Botanical Museum of Harvard University
Cambridge, Massachusetts

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# THE USE OF SOUND RECORDINGS AS VOUCHER SPECIMENS AND STIMULUS MATERIALS IN ETHNOZOOLOGICAL RESEARCH

EUGENE HUNN
*University of Washington*
*Seattle, WA 98195*

ABSTRACT.—The importance of collecting voucher specimens in ethnobotanical research is well recognized. However, collecting zoological vouchers—especially of large vertebrates—may prove beyond the capacity of many field projects. I describe the potential of field tape recordings of animal vocalizations as both vouchers and as stimulus materials for eliciting native terms and associated cultural data. Sound recordings can be at least as reliable for species documentation as photographs, study skins, or skeletal specimens, and such recordings are easily copied and edited for use in naming tasks with consultants at a later time. Basic equipment and procedures involved in making and using such recordings are also described.

RESUMEN.—La importancia de colectar especímenes comprobantes (voucher specimens) en la investigación etnobotánica ha sido ampliamente reconocida. Sin embargo, la colecta de especímenes zoológicos—especialmente de vertebrados de gran tamaño—puede estar más allá de la capacidad de muchos proyectos de campo. Describo el potencial de las grabaciones de campo de vocalizaciones animales, tanto como especímenes comprobantes como materiales de estímulo para elicitar términos indígenas y los datos culturales asociados. Las grabaciones de sonido pueden ser por lo menos tan confiables para documentar la identidad de especies como las fotografías, pieles, o esqueletos, y tales grabaciones pueden ser facilmente copiadas y editadas para uso en pruebas de identificación con consultores tiempo después. Se describen también el equipo básico y los procedimientos necesarios para hacer y usar tales grabaciones.

RÉSUMÉ.—L'importance de la collecte des échantillons de référence en ethnobotanique est reconnue depuis longtemps. Néanmoins, la collecte des échantillons de référence en ethnozoologie, surtout pour les grands vertébrés, est souvent trop difficile pour la plupart des projets de recherche sur le terrain. J'expose ici l'utilité potentielle des enregistrements de vocalisations d'animaux faits dans la nature, aussi bien en tant qu'échantillons de référence que méthode servant à stimuler des informateurs indigènes dans l'exposé de leurs savoirs biologiques populaires et des noms concernant les animaux en question. Les enregistrements peuvent être aussi utiles pour la documentation et l'étude des animaux comme le sont les photographies, les squelettes, ou les dépouilles préservées. Et les enregistrements sont facilement copiés et remaniés pour les études ultérieures de lexicographie à l'aide d'informateurs. Le matériel et la méthode employés pour faire ce genre d'enregistrements sont presentés.

The critical importance of voucher specimens in ethnobiological research has been repeatedly emphasized (Norton and Gill 1981; Bye 1986). As Bye notes (1986:2), the voucher specimen is the link between two bodies of information, that of Western biological science and that of the ethnoscience of the native culture the ethnobiologist seeks to document. For example, Sahaptin–speaking Indians of the Columbia Plateau employ a plant they call ***chalu'ksh*** for a variety of purposes, nutritional, medicinal, and as a fish poison (Meilleur et al. 1990). This fact remains an ethnographic particularity, however, until it can be established that ***chalu'ksh*** means *Lomatium dissectum* (Apiaceae). On the basis of this equation it is possible to compare a segment of Sahaptin ethnoscientific knowledge with a corresponding segment of Western botanical systematics, phenology, ecology, and pharmacology. This equation also makes possible comparisons with the ethnoscientific traditions of other cultures within the range of this species. The resulting synthesis is of greater value than the sum of its parts, the disconnected bits of ethnographic detail we would otherwise have to deal with. The link to Western biosystematics that the voucher establishes allows us to address fundamental questions, such as the nature of human knowledge itself in the context of human adaptation.

## WHAT IS A VOUCHER?

Bye (1986:1), following Lee et al. (1982), defines a voucher specimen as "an organism or sample thereof 'which physically and permanently documents data in an archival report by: (1) verifying the identity of the organism(s) used in the study, and (2) by doing so, ensure[ing] that a study which otherwise could not be replicated can be accurately reviewed or reassessed' [Lee et al. 1982:5]." To accomplish this purpose voucher specimens should meet several criteria, namely: (1) have recognized diagnostic characters; (2) be preserved and maintained in good condition, (3) be thoroughly documented, and (4) be readily accessible in a suitable repository institution (paraphrasing Bye 1986:1).

In the instance of vascular plant vouchers, standard operating procedures are well known. Basic collecting equipment such as plant presses, newsprint, hedge clips, pocket knives, and field dryers (or formaldehyde in the humid tropics) are relatively simple to obtain and use and easily transportable to the field. With minimal practice acceptable specimens can be produced by nonspecialists at an efficient rate. The accurate scientific identification of vouchers and their permanent curation, of course, require close collaboration between the field ethnobotanist and specialists based in established herbaria.

The procedures for collecting and preserving ethnozoological vouchers are not so straightforward (see Bulmer 1969 for a discussion of ethnozoological field methods). The preservation of adequate vouchers of birds in the traditional form of the museum study skin is a difficult and demanding skill that few ethnobiologists will command. Furthermore, birds are highly diverse in most of the world's regions, so that the ethnobiological researcher must deal with dozens, even hundreds of species, a number that typically exceeds by a substantial margin the number of all other terrestrial vertebrates combined. Birds are also elusive,

though they may be quite conspicuous. They must first be trapped, netted, or shot before the onerous task of preparing their skins can begin. Furthermore, most are also protected from casual hunting by national regulations and by international treaties barring their transport across national boundaries. Collecting permits are not easily obtained. Thus, unless one is collaborating with a professional museum ornithologist in the field, ornithological vouchers seem beyond reach. Yet birds are easily misidentified and vernacular bird names are notoriously idiosyncratic.

Producing a voucher specimen for a large mammal such as a jaguar, grizzly bear, or caribou, not too mention a whale, is clearly a major technical undertaking that could occupy the fieldworker for many days. Similar difficulties may be encountered by ethnobotanists, of course, as anyone who has tried to collect vouchers of columnar cacti or a coyol palm could attest (see Anderson 1971:227–231 for some creative suggestions for dealing with such problems). We normally make exceptions to the general rule that voucher specimens are required when we are dealing with large, universally recognized organisms. A photograph or reference drawing in our notes or reference to published illustrations may suffice. However, in my opinion, this is not an adequate solution in the case of birds.

Yucatec Mayan ethnoornithological vocabularies have been published on the basis of the researcher sitting down with one or two Yucatec speakers and a copy of Peterson and Chalif's *A Field Guide to Mexican Birds* (1973). Hartig's *Las Aves de Yucatan* (1979)—which lists Yucatec and/or Spanish loan ''names'' for 279 species and subspecies of birds—was compiled in this way. The results are less than satisfactory. An analysis of the Yucatec–Latin correspondences cited in Hartig demonstrates the need for fieldwork–based ''ground truthing'' to avoid incorrect and/or misleading attributions. Hartig began with a list of 491 bird taxa (species and subspecies) attributed to the Yucatan Peninsula avifauna.[1] However, she did not distinguish common species from rare, casual, and locally distributed species. This led to many overgeneralizations of native terms to species unlikely to have been familiar to her native consultants, such as the aplomado falcon *(Falco femoralis),* sandhill crane *(Grus canadensis),* white–rumped sandpiper *(Calidris fuscicollis),* and gray–cheeked thrush *(Catharus minimus),* which are rare at best on the Peninsula.

Hartig (1979) reported one to three native names for each of these 279 bird taxa (56.8% of the total listed for the Yucatan Peninsula). However, only 74 distinct folk generic names (see Berlin 1992 for definitions of terms) are included in this nomenclatural inventory. The majority of the species ''named'' are labeled by broadly inclusive descriptive terms which do not function as true names. For example, ***ch'ich'il ha'*** (water bird), used alone or with various ad hoc modifiers, is reported as the ''name'' of 17 different bird species representing five taxonomic orders (i.e., Pelecaniformes, Ciconiiformes, Anseriformes, Gruiformes, and Charadriiformes). An additional 21 species, equally eclectic, are lumped as ***bech' ha'*** (water quail), again variously and seemingly idiosyncratically modified. Given the fact that aquatic birds such as these are rarely and irregularly encountered on the Yucatan Peninsula except at favored coastal localities, it is unlikely that Hartig's main consultant—a man from a village near Valladolid—had more than

a casual acquaintance with most of these birds. In addition to overgeneralization of descriptive terms and the widespread use of nonce forms, there are numerous misidentifications. At least 50 nomenclatural assignments are clearly in error. These misidentifications appear to be due to two main factors, the consultants' difficulty distinguishing field guide illustrations drawn at different scales and their difficulty distinguishing obscurely or cryptically plumaged birds when little or no information on their vocalizations, behavior, or habitat was available. Scale is most likely the reason several bright yellow wood warblers (Parulinae, Emberizidae) were misidentified as one or another type of oriole *(Icterus,* Icterinae, Emberizidae), though the orioles are twice the linear dimensions of the wood warblers. The same difficulty may account for the equation of the Caspian tern *(Sterna caspia)* with the brown pelican *(Pelecanus occidentalis),* and the confusion of the diminutive blue–black grassquit *(Volatinia jacarina)* with the bronzed cowbird *(Molothrus aeneus).* The inadequacy of pictorial representations to distinguish obscurely plumaged birds most likely accounts for the near random assortment by her consultants of diurnal raptors (Accipitridae, Falconidae), owls (Strigiformes), nightjars (Caprimulgidae), and tyrant flycatchers (Tyrannidae) among the various named Yucatec categories appropriate to species within those larger groupings. Without some indication of the size, behavior, vocalizations, and habitat of these species the illustrations are simply inadequate as stimuli for accurate terminological responses by native consultants.

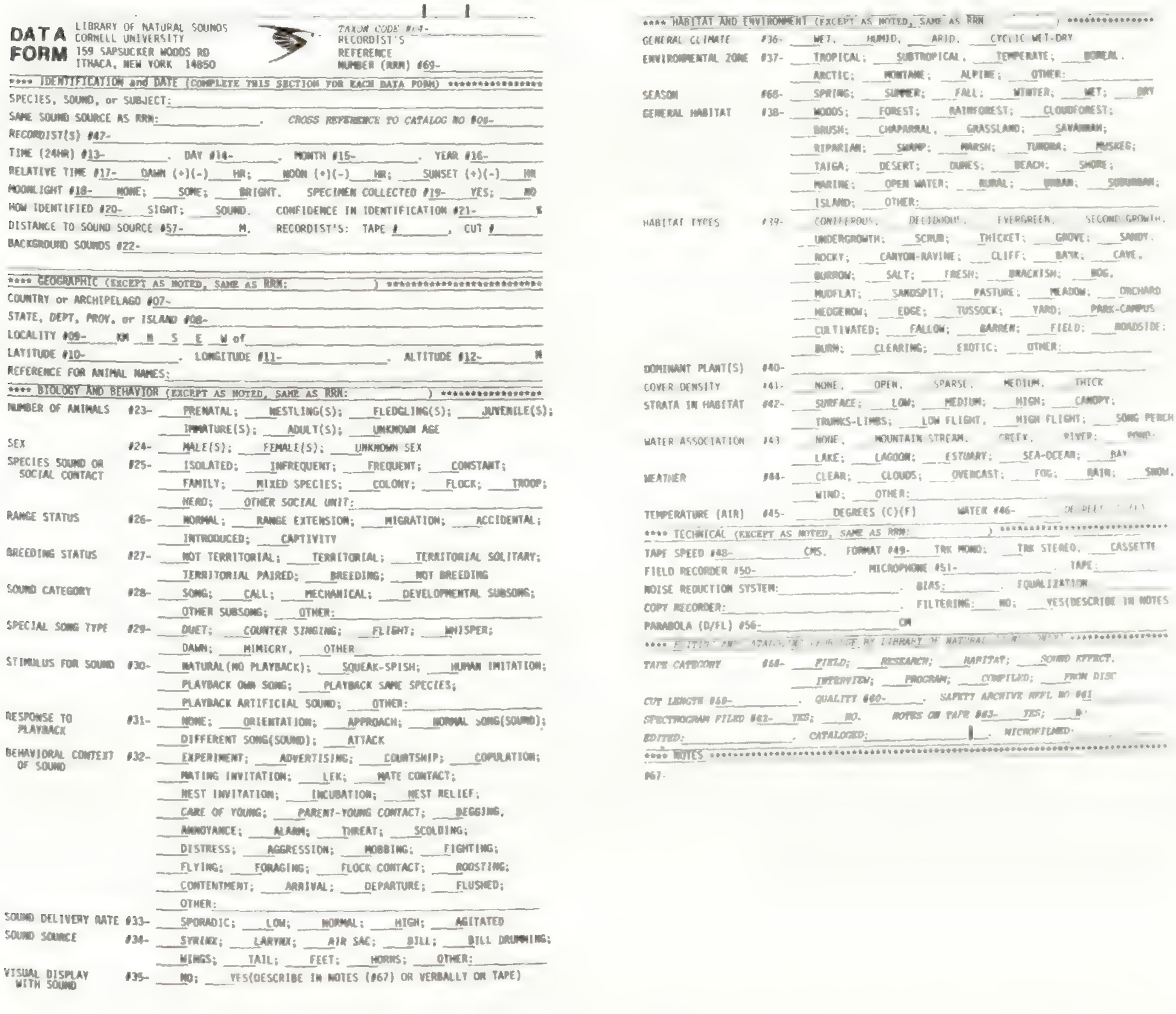
## A SOLUTION TO THE DILEMMA

A simple alternative to sole reliance on pictorial stimuli presents itself: the use of sound recordings. Such recordings may be obtained from prerecorded collections when available or recorded locally in the course of the research. The latter is preferred as it more closely links the stimulus to the specific environmental experience of one's consultants. Field guides are strictly visual, while birds, especially forest birds, are far more often heard than seen. The birds themselves recognize one another on the basis of a variety of characteristic vocalizations—songs and calls—rather than by sight. These characteristic vocalizations can be used by knowledgeable observers to identify many birds quickly and reliably at the level of species, and in some cases may reveal sex, age, and subspecific identity as well (Johnson 1982). As vocalizations are important in species recognition as well for frogs and toads, many insects, and certain mammals, the techniques described below are not relevant solely to ethnoornithological investigations.

I have recently experimented with the use of field sound recordings to elicit ethnozoological data on birds. Serendipitously I realized that these recordings made excellent voucher specimens. By depositing copies of my field recordings in a suitable archive I met two of the four criteria Bye (1986:1) cites as necessary for an adequate voucher specimen, i.e., that they "be preserved and maintained in good condition" and that they "be readily accessible in a suitable repository institution." Though at present relatively few institutional repositories exist, interest in establishing such repositories is growing, with Cornell University's

Library of Natural Sounds the leading exemplar to date[2] (see Boswall and Couzens 1982 for a list of extant collections). As of 1992, the Cornell collection includes nearly 85,000 recordings of 4,965 animal species (Gulledge 1979).

But what of Bye's two remaining criteria? Can they be met by sound recordings? The third criterion is a matter of basic research methodology: that vouchers "be thoroughly documented" means that each vocalization must be identified as to the person making the recording, the date and location of the recording, associated behavioral data, habitat associations, and technical data on the recording equipment used. The Library of Natural Sound provides donors with standard documentation forms on request, as illustrated in Fig. 1.



DATA FORM
LIBRARY OF NATURAL SOUNDS
CORNELL UNIVERSITY
159 SAPSUCKER WOODS RD
ITHACA, NEW YORK 14850

TAXON CODE #04-
RECORDIST'S REFERENCE NUMBER (RRN) #69-

**** IDENTIFICATION and DATE (COMPLETE THIS SECTION FOR EACH DATA FORM) ****
SPECIES, SOUND, or SUBJECT:
SAME SOUND SOURCE AS RRN: . CROSS REFERENCE TO CATALOG NO #08-
RECORDIST(S) #47-
TIME (24HR) #13- . DAY #14- . MONTH #15- . YEAR #16-
RELATIVE TIME #17- DAWN (+)(-) HR; NOON (+)(-) HR; SUNSET (+)(-) HR
MOONLIGHT #18- NONE; SOME; BRIGHT. SPECIMEN COLLECTED #19- YES; NO
HOW IDENTIFIED #20- SIGHT; SOUND. CONFIDENCE IN IDENTIFICATION #21- %
DISTANCE TO SOUND SOURCE #57- M. RECORDIST'S: TAPE # , CUT #
BACKGROUND SOUNDS #22-

**** GEOGRAPHIC (EXCEPT AS NOTED, SAME AS RRN: ) ****
COUNTRY or ARCHIPELAGO #07-
STATE, DEPT, PROV, or ISLAND #08-
LOCALITY #09- KM N S E W of
LATITUDE #10- . LONGITUDE #11- . ALTITUDE #12- M
REFERENCE FOR ANIMAL NAMES:

**** BIOLOGY AND BEHAVIOR (EXCEPT AS NOTED, SAME AS RRN: ) ****
NUMBER OF ANIMALS #23- PRENATAL; NESTLING(S); FLEDGLING(S); JUVENILE(S); IMMATURE(S); ADULT(S); UNKNOWN AGE
SEX #24- MALE(S); FEMALE(S); UNKNOWN SEX
SPECIES SOUND OR SOCIAL CONTACT #25- ISOLATED; INFREQUENT; FREQUENT; CONSTANT; FAMILY; MIXED SPECIES; COLONY; FLOCK; TROOP; HERD; OTHER SOCIAL UNIT:
RANGE STATUS #26- NORMAL; RANGE EXTENSION; MIGRATION; ACCIDENTAL; INTRODUCED; CAPTIVITY
BREEDING STATUS #27- NOT TERRITORIAL; TERRITORIAL; TERRITORIAL SOLITARY; TERRITORIAL PAIRED; BREEDING; NOT BREEDING
SOUND CATEGORY #28- SONG; CALL; MECHANICAL; DEVELOPMENTAL SUBSONG; OTHER SUBSONG; OTHER:
SPECIAL SONG TYPE #29- DUET; COUNTER SINGING; FLIGHT; WHISPER; DAWN; MIMICRY, OTHER
STIMULUS FOR SOUND #30- NATURAL(NO PLAYBACK); SQUEAK-SPISH; HUMAN IMITATION; PLAYBACK OWN SONG; PLAYBACK SAME SPECIES; PLAYBACK ARTIFICIAL SOUND; OTHER:
RESPONSE TO PLAYBACK #31- NONE; ORIENTATION; APPROACH; NORMAL SONG(SOUND); DIFFERENT SONG(SOUND); ATTACK
BEHAVIORAL CONTEXT OF SOUND #32- EXPERIMENT; ADVERTISING; COURTSHIP; COPULATION; MATING INVITATION; LEK; MATE CONTACT; NEST INVITATION; INCUBATION; NEST RELIEF; CARE OF YOUNG; PARENT-YOUNG CONTACT; BEGGING, ANNOYANCE; ALARM; THREAT; SCOLDING; DISTRESS; AGGRESSION; MOBBING; FIGHTING; FLYING; FORAGING; FLOCK CONTACT; ROOSTING; CONTENTMENT; ARRIVAL; DEPARTURE; FLUSHED; OTHER:
SOUND DELIVERY RATE #33- SPORADIC; LOW; NORMAL; HIGH; AGITATED
SOUND SOURCE #34- SYRINX; LARYNX; AIR SAC; BILL; BILL DRUMMING; WINGS; TAIL; FEET; HORNS; OTHER:
VISUAL DISPLAY WITH SOUND #35- NO; YES(DESCRIBE IN NOTES (#67) OR VERBALLY ON TAPE)

**** HABITAT AND ENVIRONMENT (EXCEPT AS NOTED, SAME AS RRN ) ****
GENERAL CLIMATE #36- WET, HUMID, ARID, CYCLIC WET-DRY
ENVIRONMENTAL ZONE #37- TROPICAL; SUBTROPICAL, TEMPERATE; BOREAL, ARCTIC; MONTANE; ALPINE; OTHER:
SEASON #68- SPRING; SUMMER; FALL; WINTER; WET; DRY
GENERAL HABITAT #38- WOODS; FOREST; RAINFOREST; CLOUDFOREST; BRUSH; CHAPARRAL, GRASSLAND; SAVANNAH; RIPARIAN; SWAMP; MARSH; TUNDRA; MUSKEG; TAIGA; DESERT; DUNES; BEACH; SHORE; MARINE; OPEN WATER; RURAL; URBAN; SUBURBAN; ISLAND; OTHER:
HABITAT TYPES #39- CONIFEROUS, DECIDUOUS, EVERGREEN, SECOND GROWTH, UNDERGROWTH; SCRUB; THICKET; GROVE; SANDY, ROCKY; CANYON-RAVINE; CLIFF; BANK; CAVE, BURROW; SALT; FRESH; BRACKISH; BOG, MUDFLAT; SANDSPIT; PASTURE; MEADOW; ORCHARD HEDGEROW; EDGE; TUSSOCK; YARD; PARK-CAMPUS CULTIVATED; FALLOW; BARREN; FIELD; ROADSIDE; BURN; CLEARING; EXOTIC; OTHER:
DOMINANT PLANT(S) #40-
COVER DENSITY #41- NONE, OPEN, SPARSE, MEDIUM, THICK
STRATA IN HABITAT #42- SURFACE; LOW; MEDIUM; HIGH; CANOPY; TRUNKS-LIMBS; LOW FLIGHT, HIGH FLIGHT; SONG PERCH
WATER ASSOCIATION #43 NONE, MOUNTAIN STREAM, CREEK, RIVER; POND- LAKE; LAGOON; ESTUARY; SEA-OCEAN; BAY
WEATHER #44- CLEAR; CLOUDS; OVERCAST; FOG; RAIN; SNOW, WIND; OTHER:
TEMPERATURE (AIR) #45- DEGREES (C)(F) WATER #46- DEGREES (C)(F)

**** TECHNICAL (EXCEPT AS NOTED, SAME AS RRN: ) ****
TAPE SPEED #48- CMS. FORMAT #49- TRK MONO; TRK STEREO, CASSETTE
FIELD RECORDER #50- . MICROPHONE #51- . TAPE:
NOISE REDUCTION SYSTEM: . BIAS: . EQUALIZATION
COPY RECORDER: . FILTERING: NO; YES(DESCRIBE IN NOTES
PARABOLA (D/FL) #56- CM

**** EDITING AND CATALOGING BY LIBRARY OF NATURAL SOUNDS ONLY ****
TAPE CATEGORY #58- FIELD; RESEARCH; HABITAT; SOUND EFFECT, INTERVIEW; PROGRAM; COMPILED; FROM DISC
CUT LENGTH #59- . QUALITY #60- . SAFETY ARCHIVE MFFL NO #61
SPECTROGRAM FILED #62- YES; NO. NOTES ON TAPE #63- YES; NO
EDITED: , CATALOGED: , MICROFILMED:

**** NOTES ****
#67-

FIG. 1.—Example of Data Form for recordings deposited at the Cornell University Library of Natural Sounds.

Ethnographic information elicited from native consultants during review of tapes or subsequently elicited by reference to the native names recorded in response to the recorded vocalizations may be summarized in notes submitted to the institutional repository where the voucher copies are to be housed. This summary may include in addition to local names information on uses and other

aspects of local knowledge and belief about that particular organism. Published analyses of these data are then substantiated by references to the repository catalog numbers of each voucher vocalization.

I begin each taping session by recording in my own voice the date and time, location, and habitat. If consultants or colleagues are with me, that is also noted. I record on the same tape tentative identifications of the sounds or comments on the appearance or behavior of the organisms whose vocalizations I am recording as they occur. This information may be essential to verify identifications after the fact. I wait until the particular trip is concluded to prepare a master tape log. (Master tapes are my original, real time recordings; from these I may subsequently compose tapes arranged in systematic order, or otherwise arranged for specific purposes.)

The master tape log is simply a written listing of each identifiable vocalization on the master tape in the sequence in which it has been recorded, keyed to the tape counter—an arbitrary and variable index of elapsed time. I record in this log whenever possible the presumed identity of the calling or singing bird (or frog, cicada, or cricket, etc.) that is most prominent during that tape segment. I also note bird vocalizations or other noises in the background, as this may provide clues to habitat associations and my affect consultants' interpretations. If the bird was seen at the time it was recorded and its identity confirmed by visual cues, this should be noted. (Vocalizations of uncertain identity should be confirmed visually whenever possible.)

When a tape is subsequently reviewed by a native consultant, that consultant's identifications and comments may be keyed to the specific stimulus vocalization by reference to the master tape number and position on that tape—by side and elapsed time as indicated by the tape counter. Table 1 illustrates this procedure. Ethnographic notes in this instance have been limited to native names.

TABLE 1.—Yucatan bird tape with elicited Yucatan names.[1]

| Location | f/b | English name | Yucatec ID |
|---|---|---|---|
| 2a:012–053 | fore | "hammer" cricket | ***martiyo maas*** |
| 2a:063 | back | cricket sp. #2 | — |
| 2a:068 | back | mottled owl | — |
| 2a:111–131 | fore | plain chachalaca | ***baach [bach]*** |
| 2a:135–165 | fore | mottled owl | ***kul-te'*** |
| 2a:187–215 | fore | mottled owl | ***kul-te'*** |
| 2a:210 | back | cicada sp. #1 | — |
| 2a:218+ | back | brown jay | ***pa'ap*** |
| 2a:222+ | back | cicada sp. #1 | ***ch'och' lin [chooch lin]*** |
| 2a:226–233 | back | blue-crowned motmot | — |
| 2a:236+ | back | cicada sp. | — |
| 2a:240–244 | back | mottled owl | — |

| Location | f/b | English name | Yucatec ID |
|---|---|---|---|
| 2a:249 | back | blue-crowned motmot | ***toh*** |
| 2a:255–260 | fore | collared forest-falcon | ***koos*** |
| 2a:260+ | ? | [cicada sp. #2 ?] | ***chipitin*** |
| 2a:264+ | back | barred forest-falcon | ***x-k'ipch'o'*** (in error) |
| 2a:273 | back | cicada sp. #2 | ***chipitin*** |
| 2a:282+ | fore | red-throated anttanager | ***sohlin*** |
| 2a:285–296 | fore | black-faced antthrush | ***beech' lu'um / tsimin uk'aax*** [syn] |
| 2a:301 | fore | red-throated anttanager | ***sohlin*** |
| 2a:305 | back | thicket tinamou | ***nom*** |
| 2a:313+ | back | black-headed trogon | ***mut [mut']*** |
| 2a:320 | back | spot-breasted wren | — |
| 2a:326 | fore | violaceous trogon ? | — |
| 2a:328 | back | white-fronted parrot | — |
| 2a:332 | fore | tropical gnatcatcher or vireo sp. ? | ***ts'it-kalan-ts'e'*** or ***x-tatak'-che' [tatak-che']*** [in error] |
| 2a:345 | back | barred antshrike | — |
| 2a:352+ | fore | euphonia sp. or masked tityra ? | ***chinchinbakal*** |
| 2a:357 | fore | red-eyed vireo ? | — |
| 2a:368 | fore | trill ? | — |
| 2a:369 | fore | red-eyed vireo | — |
| 2a:371 | fore | white-bellied wren | ***x-yankotil*** |
| 2a:375 | back | smoky-brown woodpecker ? | ***takay*** [in error ?] |
| 2a:376–386 | fore | black-cowled oriole | ***yuya*** |
| 2a:386+ | back | violaceous trogon | ***mut [mut']*** |
| 2a:392+ | fore | green-backed sparrow | ***chak tsitsi [chak ts'its'i]*** [in error] |
| 2b:029+ | fore | long-billed gnatwren | — |
| 2b:032 | ? | [black-faced antthrush ?] | ***beech' lu'um [bech' lu'um]*** |
| 2b:035 | back | white-bellied wren | ***x-yankotil*** |
| 2b:046+ | back | black-faced antthrush | see 2b:032 |
| 2b:050 | fore | pheasant cuckoo | ***x-baken-chulu*** |
| 2b:062 | ? | [stimulus uncertain] | ***x-takay*** [large fly-catcher sp.] |
| 2b:068 | back | melodious blackbird | ***ts'iw,*** corrected to ***pich'*** |

| Location | f/b | English name | Yucatec ID |
|---|---|---|---|
| 2b:071 | back | [stimulus uncertain] | ***hwiido [huiro]*** [rose-throated becard ?] |
| 2b:073 | fore | black-headed trogon | ***mut [mut']*** or ***uulun k'aax*** [both correct] |
| 2b:080–086 | back | large dove or pigeon sp. ? | ***tsutsuy*** *[Leptotila* dove] or ***x-chuki [chuukib]*** [scaled pigeon] |
| 2b:087 | back | violaceous trogon ? | — |
| 2b:087 | back | domestic dog | ***pek'*** |
| 2b:094–102 | fore | Yucatan flycatcher | ***x-takay,*** not ***x-k'ok' [x-kok]*** [clay-colored robin] |
| 2b:120 | fore | spot-breasted wren | ***x-yankotil*** |
| 2b:123 | back | brown jay | ***pa'ap*** |
| 2b:128 | back | [stimulus uncertain] | like ***beech' lu'um [bech' lu'um]*** [black-faced ant-thrush] |
| 2b:130 | fore | keel-billed toucan | ***panch'el*** |
| 2b:123–135 | back | [stimulus uncertain] | ***yuya*** [oriole spp.] |
| 2b:132 | back | lineated woodpecker drumming | ***kolon-te'*** |
| 2b:137 | fore | long-billed gnatwren | — |
| 2b:140+ | fore | barred forest-falcon | NR |
| 2b:152 | fore | white-fronted parrot | ***x-t'ut' [x-t'uut']*** |
| 2b:153 | back | black-headed trogon | ***uulum k'aax = mut [mut']*** |
| 2b:172 | back | flycatcher sp. ? | ***x-takay*** |
| 2b:182 | fore | green-backed sparrow | ***chak ts'its'i*** |

[1]Recorded by Eugene Hunn in the *ejido* of Chunhuhub, Quintana Roo, Mexico, 17 April 1991, in high forest *(selva mediana subperrenifolia).* Yucatec Maya identifications by Sr. Felix Medina Tzuc of Chunhuhub. Hunn's initial Yucatec transcriptions are compared with canonical forms (based on Anderson 1991) following in brackets. "Location" cites master tape number and side and tape counter position. "Fore" and "back" (f/b) refer to sounds in the foreground or background of the tape. "NR" indicates explicit non-recognition. "—" indicates no explicit comment or recognition of that vocalization. See endnote 3 for scientific names.

## AN EXAMPLE

In April 1991 I joined my colleagues Gene and Myra Anderson in Chunhuhub, a Yucatec Mayan community in Quintana Roo, Mexico, for a week of field work.

Gene and I are both avid birders, so we took walks at dawn in the forests and fields within a short radius of the town. We took these opportunities—at a season and time of day when birds are conspicuously vocal—to record a sample of their songs and calls. Gene eventually recorded 183 bird species within the boundaries of the *ejido* of Chunhuhub (Anderson 1991). Some few we heard but never saw. Most were positively identified by sight at the time or were already well known to one or both of us. Of course, ethnobiological research progresses far more rapidly when the field worker knows the subject matter well. The fact that we were able to identify confidently the great majority of the bird sounds on our tapes facilitated our questioning of consultants. Nevertheless, it is possible to use this technique even in ignorance of the identity of the birds recorded, just as one can record valuable ethnographic information concerning plant specimens of unknown identity, so long as the vouchers are subsequently identified by experts.

After the morning chorus had waned, we returned to Chunhuhub and solicited local people willing to spend an hour or two reviewing the tapes with us. We had field guides available and used both aural and visual cues as stimuli. Our local "experts" included a thirteen-year-old boy, a middle-aged woman, and an elderly subsistence farmer and hunter known for his knowledge of the local natural environment. All readily recognized the majority of the taped vocalizations, while the farmer, Sr. Felix Medina Tsuc proved to be expert indeed. He confidently named 20 species of the 32 species of birds we had been able to identify on one tape. He classified these 20 species into 18 Yucatec folk generic categories. He offered three additional Yucatec names which could not be positively equated to Western scientific taxa. He misidentified just three species (and we were uncertain as to the identities of two of these vocalizations). He did not comment on six vocalizations and appeared not to have noticed them.[3] Sr. Medina Tsuc identified a pheasant cuckoo *(Dromococcyx phasianellus)* that we were never able to see. On hearing the taped call, he accurately described the bird's appearance, behavior, and habitat preference, then pointed it out in the field guide. This consultant also distinguished nomenclaturally two types of cicadas we had inadvertently recorded in the background as well as a species of cricket—the so-called "hammer cricket" for its sharply metallic call—that I had suspected of being a frog.

Not only did he accurately identify the great majority of the taped calls, but as we reviewed the tape he took the opportunity to expound on related birds which we had not encountered, providing us a detailed comparative inventory of owls, nightjars, parrots, doves, toucans, "blackbirds," and orioles. In many cases he described the size, plumage, habitat, behavior, and cultural significance of species noted. In all he offered 55 folk generic animals names and four binomial folk specific names in response to some 45 minutes of tape.

## CRITERION NUMBER 4: DIAGNOSTIC CHARACTERS

We now come to the last of Bye's (1986:1) criteria, which is perhaps the most problematical when dealing with recorded sounds: the voucher must "have recognized diagnostic characters." In other words, experts must be able to

identify the source of the sound unambiguously, preferably to species, on the basis of the recording. Though virtually all birds have species-specific vocalizations, there may be some difficulty in associating those vocalizations accurately with species normally identified on the basis of morphological characters visible to museum taxonomists. A recent celebrated case is that of two nocturnal birds common in the Yucatan Peninsula, the Yucatan poorwill *(Nyctiphrynus yucatanicus)* and the Yucatan (aka tawny-collared) nightjar *(Caprimulgus [salvini] badius)*. Their distinctive calls had been confounded in the published literature—each attributed to the other—until the error was discovered by a group of birders employing just the sort of sound recording equipment I used in this study (Pierson 1986). They took advantage of a further useful feature of sound recordings to correct this long-standing error. They played back the bird's call immediately with the result that the calling bird came into view, seeking to drive off the unwelcome competitor—in this case, its own recorded call. Immediate playback is useful to confirm the identities of secretive forest, marsh, or nocturnal birds. In any case, properly curated vouchers are available for reevaluation in light of future advances in knowledge about birds and their vocalizations.

It is now possible to locate expert birders familiar with the avifaunas of virtually any region of the globe. These experts may not be academic scientists but rather may have gained their experience as a hobbyist or by working as professional tour guides on natural history excursions. Researchers should endeavor to contact such individuals prior to initiating their fieldwork for advice on song identifications in their target area and to contact local experts able to confirm the fieldworker's preliminary identifications. Likewise, the number and biogeographical coverage available on commercial recordings of bird songs is growing apace. Such pre-recorded collections may be used by fieldworkers to learn local bird songs and to help identify sounds they themselves record or to fill in gaps in their own field collections. (See Boswall and Couzens 1982 and Boswall 1985 for summaries of available recordings.)

An additional advantage of audiotape recordings over traditional voucher specimens is the ease with which they may be copied and edited. This facilitates professional consultations, when such are required to establish voucher identifications positively. By contrast, ethnobotanists must collect multiple—and non-identical—copies of their plant vouchers in order to have copies for circulation to taxonomic specialists. Sound recordings may be replayed any number of times with different consultants under controlled conditions to assess intracultural variation in ethnobiological knowledge. Tapes may be edited for presentation in random or nonrandom orders. Such editing requires nothing more elaborate than a "boom box" with two heads, one for playback and one for recording, though it is helpful if one's equipment allows collating commentary between edited segments.

In sum, sound recordings, if properly documented, meet all the essential requirements of voucher specimens, are relatively simple and inexpensive to collect and curate, and provide as well a flexible research instrument for systematically eliciting cultural data from a representative sample of local consultants.

## A TECHNICAL NOTE ON EQUIPMENT

For the recordings described in this paper I used a high quality portable cassette tape recorder (a Marantz PMD–221) and a Sennheiser ME–20 omnidirectional microphone head attached to a Sennheiser K3U power module. The microphone was mounted on a Sony PBR–330 13'' parabola. (For discussions of technological options see Davis 1981 and Wickstrom 1988.)

## NOTES

[1]Barbara M. de Montes (1985) has critically reviewed this list, noting a few species that should not have been listed and 37 additional species that should have been included.

[2]Ornithology Laboratory, 159 Sapsucker Woods Road, Ithaca, New York 14850, (607) 254-2473.

[3]The species he identified are: thicket tinamou *(Crypturellus cinnamomeus),* collared forest-falcon *(Micrastur semitorquatus),* plain chachalaca *(Ortalis vetula),* large dove or pigeon sp. *(Columba speciosa* or *Leptotila* sp.), white-fronted parrot *(Amazona albifrons),* pheasant cuckoo *(Dromococcyx phasianellus),* mottled owl *(Ciccaba virgata),* black-headed trogon/violaceous trogon *(Trogon melanocephalus/T. violaceus),* blue-crowned motmot *(Momotus momota),* keel-billed toucan *(Ramphastos sulphuratus),* lineated woodpecker *(Dryocopus lineatus),* black-faced ant-thrush *(Formicarius analis),* Yucatan flycatcher *(Myiarchus yucatanensis),* brown jay *(Cyanocorax morio),* spot-breasted wren/white-bellied wren *(Thryothorus maculipectus/Uropsila leucogastra),* red-throated ant-tanager *(Habia fuscicauda), Euphonia* sp., melodious blackbird *(Dives dives),* black-cowled oriole *(Icterus dominicensis).* Species apparently misidentified include smoky-brown woodpecker *(Veniliornis fumigatus)* [I am uncertain if the sound he was responding to was produced by this species or some other in the background of the tape], tropical gnat-catcher *(Polioptila plumbea)* or *Vireo* sp. [I am uncertain of the identity of the sounds to which he was responding], and green-backed sparrow *(Arremonops chloronotus)* [which he twice called by the term presumed to name the northern cardinal *(Cardinalis cardinalis)].* He initially misidentified the calls of the barred forest-falcon *(Micrastur ruficollis)* as the squirrel cuckoo *(Piaya cayana),* but later changed his mind to declare the sound unfamiliar. In fact, it is possible that the barred forest-falcon is extremely rare in this part of the Yucatan Peninsula. Species for which no names were offered include a backgrounded barred antshrike *(Thamnophilus doliatus),* long-billed gnatwren *(Ramphocaenus melanurus),* and red-eyed vireo *(Vireo violaceus).* Vocalizations named in Yucatec but not identified scientifically include ''like ***beech' lu'um***'' ''like the black-faced antthrush''; ***hwiido*** for what may have been calls of a rose-throated becard *(Pachyramphus aglaiae),* and ***yuya*** for what may have been a second species of oriole *(Icterus* sp.).

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## BOOK REVIEW

**The Origins of Agriculture and Settled Life.** Richard S. MacNeish. Norman: University of Oklahoma Press, 1992. Pp. xix, 433. $75.00. ISBN 0–8061–2364–8.

No one has dug more assiduously in more agricultural homelands than Richard MacNeish. Given MacNeish's experience, and his creative and original mind, it is not surprising that he has produced a benchmark work on agricultural origins.

This book is not a full review of the "origins of agriculture" literature, though MacNeish does provide a 38-page bibliography. Rather, the book represents the model of agricultural development that MacNeish has been developing while excavating early agricultural sequences in Peru, Mexico, and the American Southwest.

MacNeish is too experienced to rely on one or two factors. He stands at the opposite end of the spectrum from the simplistic "population pressure" model of Cohen (1977) or Rindos's reduction of domestication to a virtually accidental biological side-effect of plant exploitation (Rindos 1984). MacNeish integrates these ideas with many others.

MacNeish allows four primary areas: Peru, Mexico, the Near East (the earliest in time), and north-central China. This parsimonious view has recently been independently endorsed by Blumler (1992), who thinks there might have been only two (Mexico and the Near East). By contrast, Cohen's and Rindos's models would both predict randomly distributed and quite frequent and rapid transitions to farming. MacNeish has pointed out that, in all primary areas, domesticated crops produced only about 5% of the food supply for literally thousands of years. People forced to farm because of hunger would change much more rapidly than that—or else starve to death.

At the end of the Pleistocene, megafauna became extinct and people had to turn to smaller food sources. In certain parts of the world strongly seasonal climates emerged. In such areas, affluent hunting groups became what MacNeish calls "destitute foraging bands." It seems that these bands were not really destitute; they had to shift from mobile hunting to more local seasonal-round cycles and macroband/microband alternation. They also found plants that are easy to domesticate: annuals or short-generation perennials that have many edible seeds or tubers and are genetically plastic. In such areas, primary agriculture emerged, if there was intensive contact between groups, and thus sharing of ideas and foods.

Only four places in the world appear to meet all these criteria. Much of the world was too homogeneous, or conversely, had such rich variety in one spot that people did not feel a need to domesticate. I believe MacNeish would agree with earlier authors that places like southern South America and southern Africa are culs-de-sac, lacking the necessary intensive contact between groups.

Secondary domestication took place in areas nearby, where people could satisfy their immediate needs without moving seasonally. They had less incentive to develop and intensify a resource that could be stored and moved. Population increase in the more circumscribed of these spots—notably river valleys in dry areas—would lead to resource overuse, and thus to borrowing agriculture. Readers will be reminded of Carneiro's "circumscription hypothesis" (Carneiro 1970), as well as of Mark Cohen's work in Peru (Cohen 1977).

Tertiary domestication is yet another process. This involved a moving fringe of agriculture expanding slowly over the landscape. The landscape is thus predicted to be relatively homogeneous. It will also have fewer easily domesticable plants—i.e., it will probably be a forest or a shrub desert. Europe is the obvious type case, but something similar seems to have happened in Japan, southwestern and eastern North America, and other areas. This has previously been explained as natural diffusion of a good idea, or as expansion of one population group—a theory argued for Europe by Cavalli-Sforza and associates (Ammerman and Cavalli-Sforza 1984), but hardly defensible for any of the other areas. (Consider the linguistic diversity of the American areas.) MacNeish sees it as a different process; sedentary groups built up population, borrowed a few domesticates, traded food, built up more population, and had to intensify further.

In all three situations, a feedback loop emerges once people are reliant on agriculture for a significant percentage of their food: their population grows, they are less able to pick up and move, and they are more skilled at plant breeding

and domestication. Intensifying agriculture becomes a more and more persuasive option. MacNeish tests the evidence against available world data, including some 50 key sequences from key areas. He predicts that more sequences will only strengthen his case.

Some footnotes to this theory are in order. First, in all four of these areas, the earliest known domestication coincides with the arrival of warmer and wetter climates that would allow annual plants to expand. In the Pleistocene, any good Neoclassical microeconomist advising a hunting band would have told them to get more mobile and invent better hunting gear—the payoff lay in getting more meat with less effort. This is exactly what they did. In the post–Pleistocene, with game drastically reduced and plants increasing, the advisor would recommend diversifying the portfolio and looking to growth stock (sheep and goats, guinea pigs, llamas ...) and grain futures. This is what happened. We need not invoke population pressure—common sense, perhaps glorified as "optimal foraging theory," will do.

It is well to remember, also, Sauer's point that the original domesticators must have been affluent enough to try a process that is highly chancy and slow to pay off (Sauer 1969). New processes take time to develop, failures are typical, and those thousands of years when cultivation provided only 5% of the food are easy to understand. The same phenomenon, today, explains the fact that almost all agricultural research and innovation is in the richest nations.

The importance of MacNeish's "intensive interactions" among the primary producers also deserves more attention—as MacNeish has said in other papers (e.g., MacNeish 1977). People can find something to domesticate almost anywhere, and there are many diverse habitats that require humans to move around. More critical is a source of ideas and some pressure to use them. Trade provides the ideas and some incentive. People would want to raise crops near the house to have them easily available for trade. This may explain why so many early cultigens were portable luxuries such as chile peppers, bottle gourds, and tobacco. Raid also provides incentive. It makes people desire to raise all their food within a defensible perimeter. Warfare is common in traditional societies. It keeps population growth rates down, and creates pressure for food concentration and storage. Thus it can substitute for population pressure as a source of strong incentive to intensify agriculture. Surely, it is no accident that the four primary centers and most of the secondary centers are in areas that have always been "crossroads of continents."

MacNeish's model receives independent verification from recent findings in China (Chang 1986; Ping-ti Ho 1988) and the Near East. In China, some of the questions MacNeish asks of the data have been resolved recently, and MacNeish's model wins. The earliest agriculture known is in an area of dry valleys and lusher mountains, with many ecozones not quite accessible from one site (personal observation). In the latter case, McCorriston and Hole (1991) have recently argued for the Jordan Valley as the origin point, but most of the earliest crops find their closest living relatives in the area of the Turkey–Syria–Iraq tri-point (Giles Waines, personal communication). Either areas fits MacNeish's model for the Near East.

The main problem with MacNeish's book is the high number of errors. The proofreading, editing, and production of this book do no credit to the University of Oklahoma Press. K.C. Chang's *The Archaeology of Ancient China* appears as *The Archaic of Ancient China,* and is cited to a long-superseded edition. Scientific and common names in the tables of cultivated plants are very frequently mis-written.

Three controversial matters should be mentioned. First and least important, MacNeish separates teosinte from true "corn" (p. 110), unlike most contemporary scholars. Second, MacNeish credits Europe with spelt, millet, and apples—all quite possibly domesticated in Asia. Third, MacNeish is famous for his acceptance of very early dates for the entry of humans into the New World. This does not affect his arguments in this book, but more than a few archaeologists will be put off by the background sections of the chapters on New World areas.

This book provides the best model yet published for the origins of agriculture. Its author's formidable experience with the data makes him worth the serious attention of anyone interested in the question.

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E.N. Anderson
Department of Anthropology
University of California
Riverside, CA

# BOOK REVIEW

**An Introduction to Tropical Rainforests.** T. C. Whitmore. Oxford, U.K.: Clarendon Press, 1990, and New York: Oxford University Press (reprinted with corrections), 1991. Pp. xii, 226. $35.00. ISBN 0-19-854276-3.

> There seemed to be a need for a book that looked at all aspects of tropical rainforests and mankind's impact upon them, yet in a concise text written so as to be readily understood by the concerned layman as well as the non-specialist college student. The aim of this book is to provide an introduction to the world's tropical rain forests ... to describe their structure and functioning, their value to man and what he is doing to them.

These expectations of the author have indeed been fully achieved in this valuable book. Only a few such books by authorities have appeared that equal this volume, which is condensed but inclusive. The use of tables and charts does much to present an extraordinary amount of information which otherwise would have required pages of text. But even the text is terse, clean-cut, and always pertinent. This characteristic, plus the author's extensive experience, makes the book valuable for general readers newly interested in conservation as well as experts in the field; as a former university teacher, I recommend the book especially as a text for courses in rain forest conservation or even conservation of other forests in the tropics.

The book is divided into ten chapters: (1) An introduction to tropical rain forests; (2) What are tropical rain forests?; (3) Plant life; (4) Rain forest animals; (5) Relationships between plants and animals; (6) Tropical rain forests through time; (7) Forest dynamics; (8) Nutrients and their cycles; (9) Species richness; and (10) Tropical rain forests yesterday, today, and tomorrow. There follows an epilogue with notes, references, a glossary, a general index, and an index of plants and forest products.

As a botanical explorer of the northwest Amazon for 47 years, I find this book exceedingly useful and a welcome addition to my own extensive library on Amazonia.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, MA 02138

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# PREHISTORIC MEDICINAL PLANT USAGE: A CASE STUDY FROM COPROLITES

KRISTIN D. SOBOLIK
*Department of Anthropology and*
*Institute for Quaternary Studies*
*University of Maine*
*Orono, ME 04469*

and

DEBORAH J. GERICK
*Department of Anthropology*
*Texas A&M University*
*College Station, TX 77843*

ABSTRACT.—Identifying medicinal plant usage from the prehistoric record is problematic due to the preservation of such information, and the lack of conclusive evidence provided through dietary and non-dietary assemblages. One of the most direct methods of determining prehistoric medicinal plant usage is through the analysis of coprolites. This paper presents data gained through an analysis of 32 Archaic coprolites from Caldwell Cave, Culberson County, in west Texas. The coprolites were analyzed for their pollen content in an attempt to identify flowers and/or inflorescences ingested purely for their medicinal value. High frequencies of *Ephedra* (Mormon tea) and *Prosopis* (mesquite) pollen were observed in the coprolites, and since these plants are known as diarrhetics, it is postulated that the Archaic peoples of Caldwell Cave probably used these plants as medicinal diarrhetics.

RESUMEN.—La identificación del uso de plantas con fines medicinales en el registro prehistórico es problemática dada la preservación de tal información y la carencia de evidencia concluyente proporcionada por colecciones dietéticas y no dietéticas. Uno de los métodos más directos para verificar el uso prehistórico de plantas medicinales es el análisis de coprolitos. Este trabajo presenta información generada a través del análisis de 32 coprolitos arcaicos de la cueva Caldwell, condado de Culbertson, en el occidente de Texas. Los coprolitos fueron analizados por su contenido de polen, en un intento de verificar la presencia de flores y/o inflorescenias ingeridas puramente por su valor medicinal. Se observaron frecuencias altas de polen de *Ephedra* (canutillo o tepopote) y *Prosopis* (mezquite). Puesto que estas plantas son conocidas como diarreicas, se postula que las gentes del período arcaico de la cueva Caldwell probablemente usaron estas plantas como diarreicas medicinales.

RÉSUMÉ.—À cause de la rareté de leur conservation et l'absence d'évidence conclusive à partir d'assemblages alimentaires et non-alimentaires, il est difficile de fournir témoignage sur l'emploi des herbes pharmaceutiques dans la préhistoire. L'analyse des coprolithes humains est une des méthodes les plus directes pour déterminer l'usage préhistoriques des herbes médicinales. Cette étude présente des résultats obtenus par l'analyse d'un échantillon de 32 coprolithes humains découverts dans la Caverne de Caldwell, un gisement préhistorique datant de la période Archaïque et situé dans le Département de Culberson au Texas Occidental (États Unis). Le pollen trouvé dans les coprolithes a été étudié de facon à déterminer la présence de fleurs ou d'inflorescences consommées seulement pour leur valeur médicinale. Des pollens de genres *Ephedra* (thé des Mormons) et *Prosopis* (mesquite) ont été observés fréquemment dans les coprolithes. Ces herbes sont connues actuellement comme médicaments contre la diarrhée. Par consequence, il est suggéré que les peuples Archaïques de la Caverne de Caldwell ont probablement consommé ces herbes comme médicaments contre la diarrhée.

## INTRODUCTION

Documenting prehistoric medicinal plant usage is problematic because it is difficult to distinguish between plants that were consumed for dietary purposes and those consumed for medicinal purposes only. Many times plants were probably used both as foods and as medicines. The analysis of plant remains from archaeological sites is often used to reveal dietary and medicinal intake, although such data are actually an indirect estimation of subsistence. Plant remains in archaeological sites can be deposited through a number of channels, most significantly through contamination from outside sources (i.e., water, wind, matrix shifts, and animals). Prehistoric people used plants to produce clothing, shelter, basketry, and twining. Plants used for these purposes become deposited into archaeological contexts and can be mistaken for food or medicinal items.

One of the best methods to determine prehistoric medicinal and dietary consumption directly is through the analysis of human coprolites (dessicated human feces)(Bryant 1974). The analysis of coprolites can provide information on prehistoric medicinal usage (Reinhard 1991), because coprolites contain the undigested remains of meals that were consumed either a few days before (i.e., macroremains) or up to one month before (i.e., pollen)(Kelso 1976; Williams-Dean 1978; Sobolik 1988).

In this paper we present information gained from the analysis of the pollen content of 32 coprolites recovered from Caldwell Cave, Culberson County, western Texas. Analysis of the coprolites reveals a direct correlation between the presence of plants useful for alleviating diarrhea and coprolites which were diarrhetic. This correlation suggests that the prehistoric population of Caldwell Cave was ingesting medicinal plants to help alleviate chronic diarrhea. These plants include *Ephedra* (Mormon tea) and *Prosopis* (mesquite). This analysis confirms the inconclusive evidence provided through the study conducted by Holloway (1983) which indicated that the Caldwell Cave occupants were possibly using *Ephedra* and *Larrea* (creosote bush) in medicinal teas to help cure chronic diarrhea.

## BACKGROUND

Caldwell Cave (41CU1) is a sink-hole located in the east central portion of Culberson County (Fig. 1). Caldwell Cave was occupied from approximately A.D. 1200–1450 (Tanner 1949). The prehistoric peoples occupying Caldwell Cave

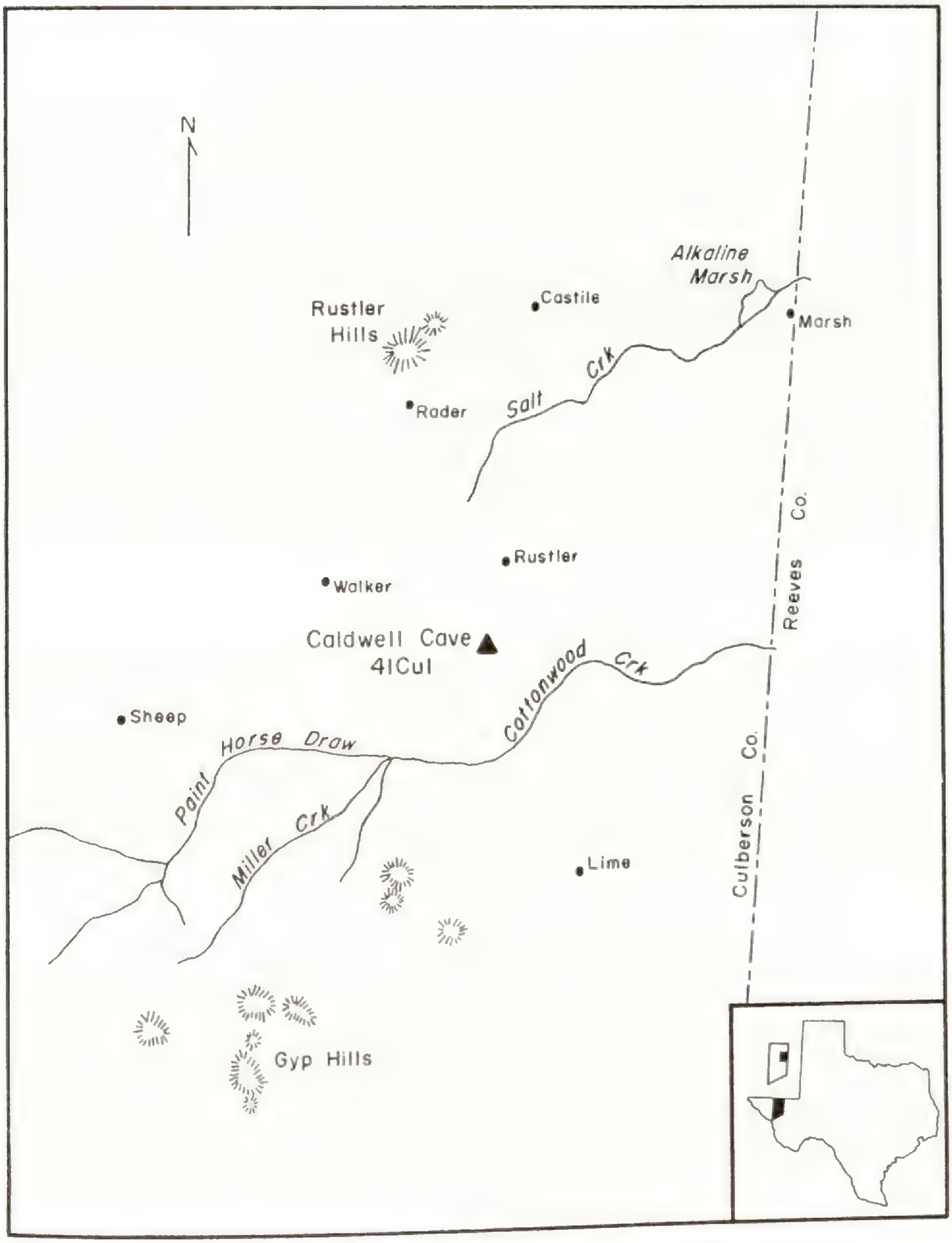


FIG. 1.—Location of Caldwell Cave, Culberson County, Texas.

and the surrounding area were hunter-gatherers throughout this time period (Jackson 1937; Tanner 1949).

Past and present observations of the coprolite samples indicate that chronic diarrhea was a prevalent health problem for the Caldwell Cave occupants. Chronic diarrhea may have been caused by high gypsum content in the local water supply—there is a gypsum stratum underlying the limestone surface of the area (Sayles 1941). Chemical analysis of a local spring revealed a high content of magnesium, which is a common ingredient in laxatives (Holloway 1983:Table 5).

Although analyses of coprolites from Culberson County are scarce, a few studies have been conducted: Holloway (1983) analyzed eight coprolites from Caldwell Cave, and Caldwell and Murry (Murry 1980) analyzed 16 coprolites and the colon contents of a mummified child from Granado Cave (41CU8). Holloway (1983) suggested that Mormon tea and creosote bush pollen were ingested as medicinal diarrhetics. However, Mormon tea pollen was observed in this study at a low frequency (10.7%), indicating that *Ephedra* pollen may not have been intentionally ingested. The sample which contained *Ephedra* pollen was not diarrhetic. One sample also contained *Larrea* pollen at a frequency of 18.7% indicating that this plant may have been ingested intentionally. The sample which contained *Larrea* pollen was diarrhetic. Holloway (1983) also observed high frequencies of grass pollen and seeds in most of the samples, high percentages of sagebrush pollen in two samples, and a high percentage of Hydrophyllaceae (water leaf) pollen in one sample. Murry (1980) also observed high frequencies of Mormon tea pollen (above 95%) in two of the samples he analyzed.

## METHODS AND MATERIALS

The 32 coprolites used in this study were recovered by D.L. Hamilton and were analyzed for pollen and macroremain content. The samples were initially divided into four morphological categories following the methodology instigated by Holloway (1983:Table 1): type I, solid, firm, well-formed; type II, soft, well-formed; type III, soft, not well-formed; and type IV, soft, paddy-like, apparently runny. Because it proved difficult to distinguish morphological categories II and III, they were combined into one category, II/III. These categories were useful in determining general health (Holloway 1983), and in indicating which coprolites were diarrhetic.

The coprolites were processed following standard techniques (Fry 1985) and exotic *Lycopodium* tracers (11,300 ± 400 spores) were added to the samples in order to calculate overall pollen concentration (Table 1). Pollen concentration values (number of pollen grains/gram of material) for each coprolite were calculated by multiplying the number of tracer grains added by the number of fossil grains counted and dividing that product by the product of the number of tracer grains counted times the amount of sediment processed.

Calculating pollen concentration values from coprolites is important to determine which pollen types were most likely intentionally ingested (Sobolik 1988) and possibly used as medicines. Modern fecal studies have shown that the more

recently a pollen type was ingested the higher concentration value a fecal sample will have (Kelso 1976; Williams–Dean 1978). As the time from ingestion of a pollen type lengthens, the pollen concentration value for that sample decreases. The reason for this decrease is that pollen tends to become caught in the intestinal luminal folds and can be excreted many days after initial ingestion. Some pollen types can be excreted for up to one month after ingestion (Williams–Dean 1978).

Presence of high pollen concentration values in coprolites therefore indicate that the economic pollen types observed in the samples were ingested recently. Concentration values of over 100,000 pollen grains/gram of material usually indicate that pollen was recently ingested (Sobolik 1988). Samples which contain less than this amount may contain economic pollen types that were intentionally ingested many days before the sample was deposited (Sobolik 1988, 1991). Such samples will also contain a wide variety of unintentionally ingested, background pollen types. Therefore it is harder to recognize intentionally ingested pollen types in samples which contain less than 100,000 pollen grains/gram of material. Other factors influencing pollen abundance, such as the amount of pollen a plant produces and dispersal method, should also be considered in assessing the significance of the pollen.

## DISCUSSION

The prehistoric Caldwell Cave population intentionally ingested at least four pollen types (Table 1). These pollen types are considered economic because they occur in high frequencies in the samples and most likely do not indicate accidental ingestion of pollen through contamination on food, in water supplies, and through breathing. The four economic pollen types are grass (Poaceae), Mormon tea *(Ephedra),* mesquite *(Prosopis),* and cactus (Cactaceae of the non–*Opuntia* type).

Twelve of the Caldwell Cave coprolites had concentration values of over 100,000 pollen grains/gram of material; ten samples contained extremely high percentages of grass pollen and aggregates; one sample contained a high frequency of cactus pollen; one sample contained a high frequency of Mormon tea pollen (Table 1). The high concentration values of these samples suggest that grass, Morman tea, and cactus flowers or inforescences were most likely intentionally ingested only a few days before the samples were deposited.

Grass pollen is particularly prevalent in the coprolite samples. Grass pollen, which is wind–pollinated, was found at high frequencies in 29 of the 30 samples which contained a statistically valid pollen count. A majority of the samples with abundant grass pollen also contained aggregates of grass pollen, possibly indicating the ingestion of anthers. The presence of pollen aggregates in non–coprolitic samples may, however, indicate a variety of depositional patterns (Gish 1991). The one coprolite sample which did not contain a high frequency of grass pollen, sample 28, contained a high frequency of Cactaceae pollen and aggregates of this type. Grass pollen was observed in samples which had high, intermediate, and low concentration values indicating variation in the length of time from

TABLE 1.— Major pollen frequencies from the Caldwell Cave coprolites.

| Sample Number | Morph. Category | *Ephedra* % | *Prosopis* % | Cactaceae % | Poaceae % | Concentration Values | Count Totals |
|---|---|---|---|---|---|---|---|
| 1 | I | 0 | 0 | 1 | 91 a | 105,805.2 | 250 |
| 2 | I | 1 | 0 | 0 | 98 a | 240,125.0 | 238 |
| 3 | II/III | 0 | 0 | 0 | 98 a | 283,233.8 | 386 |
| 4 | II/III | 0 | 0 | 1 | 85 a | 120,860.9 | 246 |
| 6 | II/III | 0 | 0 | 0 | 45 | 4,731.5 | 204 |
| 7 | II/III | 2 | 0 | 0 | 37 | 15,281.9 | 213 |
| 8 | II/III | 0 | 0 | 0 | 20 | 9,746.3 | 207 |
| 10 | II/III | 4 | 0 | 18 | 24 | 5,244.8 | 200 |
| 11 | II/III | 0 | 0 | 0 | 80 a | 77,549.0 | 210 |
| 12 | II/III | 0 | 0 | 0 | 92 a | 154,433.3 | 205 |
| 13 | II/III | 0 | 0 | 0 | 31 | 35,123.7 | 221 |
| 14 | II/III | 0 | 0 | 0 | 91 a | 80,440.7 | 210 |
| 15 | II/III | 0 | 0 | 0 | 98 a | 700,376.2 | 313 |
| 16 | II/III | 0 | 1 | 0 | 93 a | 254,684.6 | 293 |
| 17 | II/III | 0 | 0 | 0 | 87 a | 110,684.4 | 239 |
| 18 | II/III | 0 | 1 | 0 | 89 a | 27,775.2 | 234 |
| 19 | II/III | 4 | 47 | 0 | 18 | 21,375.8 | 227 |
| 20 | IV | 0 | 1 | 0 | 96 a | 96,857.1 | 216 |
| 21 | IV | 0 | 0 | 2 | 36 | 3,550.7 | 200 |
| 22 | IV | 0 | 3 | 1 | 38 | 8,999.6 | 205 |
| 23 | IV | 4 | 6 | 2 | 43 | 9,658.1 | 200 |
| 24 | IV | 2 | 0 | 0 | 49 | 9,783.5 | 200 |
| 25 | IV | 0 | 0 | 0 | 98 a | 300,923.9 | 245 |
| 26 | IV | 47 | 0 | 0 | 23 | 67,261.9 | 200 |
| 27 | IV | 75 | 1 | 0 | 12 | 303,277.4 | 416 |
| 28 | IV | 0 | 2 | 91 a | 2 | 128,866.4 | 222 |
| 29 | IV | 0 | 0 | 0 | 86 a | 113,758.4 | 200 |
| 30 | IV | 1 | 1 | 0 | 47 | 3,705.7 | 223 |
| 31 | IV | 5 | 41 | 1 | 25 a | 67,472.5 | 206 |
| 32 | IV | 51 | 0 | 1 | 22 | 96,660.8 | 211 |

a = aggregates

ingestion of grass pollen to sample deposition. Grass pollen may become ingested by eating grass seeds, which, due to their small size, are difficult to separate from grass inflorescences. Holloway (1983) also observed high percentages of grass pollen in the eight samples he analyzed, and Murry (1980) observed grass pollen in one sample, although he states that the sample may not be human.

*Ephedra* pollen was found at high frequencies in three of the Caldwell Cave coprolite samples (samples 26, 27, and 32), although only one sample contained a pollen concentration value above 100,000 grains/gram of material. All samples containing a high frequency of *Ephedra* pollen were in morphological category IV, indicating that the coprolites were diarrhetic. This suggests that only people with diarrheal problems ingested Mormon tea, possibly in medicinal teas to help cure their problem.

Mormon tea pollen, leaves, and stems are widely used as a diarrhetic; *Ephedra* is considered one of the most prevalent medicinal remedies for diarrhea both prehistorically and historically (Burlage 1968; Niethammer 1974; Moore 1979; Moerman 1986). Mormon tea was also used as a cure for syphilis (Burlage 1968; Niethammer 1974), and the ephedrine-related alkaloid in Mormon tea is a decongestant (Moore 1979).

Holloway (1983) observed *Ephedra* at a frequency of 10.7% in one coprolite (morphological type I). This frequency is relatively low, too low to conclude that *Ephedra* was definitely an economic pollen type in this sample, especially considering that *Ephedra* is wind-pollinated—its pollen occurs in the environment at higher frequencies than insect-pollinated types. *Ephedra* may be economic in this case, however, if it was ingested some time before the sample was deposited (Sobolik 1988). Murry (1980) observed *Ephedra* at high frequencies (92%, 86%) in two of the samples he analyzed.

Cactaceae pollen (of the non-*Opuntia* variety) was observed at high frequencies in sample 28 (morphological category IV). This sample also had a high pollen concentration value (Table 1). Pollen of Cactaceae, which are insect-pollinated plants, was also observed at a high frequency (79.3%) in the colon contents of a mummified child, which also contained tiny non-*Opuntia* cactus seeds (Murry 1980). Cactaceae pollen was not observed in other coprolites analyzed from the area.

The coprolite samples which exhibited pollen concentration values less than 100,000 pollen grains/gram of material contained high frequencies of pollen types which may also be economic. Grass pollen was again observed in a large number of these samples, indicating that it was ingested many days before the sample was deposited. The high frequencies of grass pollen present suggest that this pollen type was most likely intentionally ingested. Mormon tea and mesquite pollen were also observed in two of the samples with concentration values less than 100,000 pollen grains/gram of material at frequencies suggesting that they were most likely intentionally ingested.

Samples 19 and 31 contain high frequencies of insect-pollinated *Prosopis* (mesquite) pollen but have only intermediate pollen concentration values (Table 1). One of the coprolites with abundant mesquite pollen was in morphological

category IV and one in morphological category II/III. This indicates that mesquite may have been used to help cure diarrhea, although other uses are also possible. For example, mesquite leaves are useful as a medicinal tea for stomach ailments and to cleanse the system (Neithammer 1974). In the process of preparing mesquite leaves for a medicinal tea, pollen could also become incorporated into the tea, either intentionally or unintentionally. Mesquite also may have been ingested as a food source, rather than for purely medicinal advantages. The Cahuilla used mesquite catkins as a food (Bean and Saubel 1972), and the Pima sucked the catkins as a sweet (Curtin 1949). Mesquite pollen was not observed in other coprolite studies in the area.

## CONCLUSION

Analysis of the pollen content of Caldwell Cave coprolites indicates the probable ingestion of Mormon tea *(Ephedra)* and the possible ingestion of mesquite *(Prosopis)* pollen in medicinal teas to help cure diarrhea. There is a strong correlation of diarrhetic coprolites with high frequencies of Mormon tea pollen; one diarrhetic coprolite contained a high frequency of mesquite pollen.

The addition of the present study of 32 coprolites to the previous study of eight coprolites from Caldwell Cave (Holloway 1983), strengthens the conclusion that the prehistoric inhabitants of the area used *Ephedra* pollen in medicinal teas to cure diarrhea. *Prosopis* and *Larrea* pollen may also have been used for the same purpose.

Determining prehistoric medicinal plant usage is difficult, since plants were also used extensively as foods and for other purposes. The best indications of medicinal plant usage are provided through the analysis of coprolites, particularly pollen content. Analysis of the Caldwell Cave coprolites demonstrates that it is possible to determine prehistoric medicinal plant use through careful analysis of the pollen preserved in coprolites.

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# BOOK REVIEW

**Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany, and Use.** Harriet V. Kuhnlein and Nancy J. Turner. Volume 8 in the Food and Nutrition in History and Anthropology Series, edited by Solomon Katz. New York and Philadelphia: Gordon and Breach Science Publishers, 1991. Pp. xi, 620. 48 figures, 3 maps. $88.00 (hardbound), $38.00 for individuals who are members of Science and Arts Society. ISBN 2–88124–465–3.

Ethnobotanical studies amongst Aboriginal Peoples in most parts of North America are ''few and far between.'' It is indeed encouraging that such a highly

detailed and thorough report on food plants and nutrition of the Indigenous Peoples of Canada has appeared. The two authors—a well known nutritionist from McGill University and a widely respected ethnobotanist—are to be congratulated for their presentation of such a masterly contribution.

The forward by Laurie Montour, a Native Canadian and a staff member of the Assembly of First Nations, sets the tone of the book: ''We need to work hard together to preserve our knowledge and to protect the environments of the plant foods of the world's indigenous people. This book is a good step along the way.'' In the Acknowledgments, the authors indicate the great number of individuals—aboriginal consultants, students, governmental agencies, and scientific colleagues—whose contributions have helped make this book the encyclopedic masterpiece that it is. The Introduction, Chapter 1, tells us that ''The scientific literature was searched for nutrient information of approximately 1,050 species that were identified as edible and available in Canada,'' and that ''... nutritional, botanical and ethnological data for more than 1,000 species of edible plants'' are included.

There follows Chapter 2, ''What's So Special About Indigenous Foods?'' Amongst other ''specialties'' is the usefulness of information in ''genetic research, in enhancing existing crops or ... developing new ones.'' Chapter 3 deals in depth with ''An Overview of the Nutrient Value and Use of Plant Foods by Indigenous Peoples.'' In the fourth chapter—a major section of the book—are considered the botany and methods of use of indigenous plant foods of Canada. A comprehensive list of plant food species makes up Chapter 5, a convenient tabular summary of earlier chapters. Another tabular chapter deals with ''Nutrient Values of Traditional Plant Foods''—a most useful addition that occupies 162 pages.

The Bibliography comprises 519 items and is followed by three Appendices: Linguistic Affiliations and Locations of Indigenous Peoples of Canada (with three maps); Species by Common Name; and Species by Botanical Name. The Index contains both common and scientific plant names, and nutritional and other chemical constituents of the food plants.

This volume will certainly long remain an example of the very finest in ethnobotanical literature. Furthermore, its utility will be evident as a manual for quick consultation by specialists, as a valuable text or classroom reference work, and as an instrument furthering the development of the interdisciplinary field of ethnobotany.

Richard Evans Schultes
Director Emeritus
Botanical Museum of Harvard University
Cambridge, Massachusetts

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# RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS: FALL 1991–FALL 1992

TERENCE E. HAYS
*Department of Anthropology and Geography*
*Rhode Island College*
*Providence, RI 02908*
and
JOSEPH E. LAFERRIÈRE
*Arnold Arboretum of Harvard University*
*22 Divinity Avenue*
*Cambridge, MA 02138*

This is the tenth in an annual series of bibliographies listing selected dissertations drawn from the pages of Dissertation Abstracts (D.A.). All listings were made by scanning the titles and abstracts published in D.A. and making subjective decisions as to which ones might be relevant to work in ethnobiology or related disciplines such as ecological anthropology and economic botany.

Dissertations categorized in D.A. under Agricultural Economics, Agriculture, American Studies, Anthropology, Biology, Botany, Chemistry, Ecology, Folklore, Geography, Health Science, Home Economics, Language, Linguistics, Paleoecology, Physical Geography, Sociology, and Zoology were considered for inclusion in the list. An attempt was made to be as inclusive as possible, but some dissertations may have been overlooked. Comments and suggestions would be welcome for items to include in next year's edition.

Dates covered by the present paper include: Volume A (Humanities and Social Sciences): September 1991–August 1992; Volume B (Sciences and Engineering): September 1991–August 1992; Volume C (European Dissertations): Fall 1991–Summer 1992. Note that these are the dates for the issues of D.A. in which the abstracts appear, rather than the dates of acceptance of the dissertations themselves.

The dissertations are listed below alphabeticaly by author, along with the year of acceptance, title, institution, length, adviser or major professor, number(s) of the page(s) in D.A. on which the abstract may be found, University Microfilms order number, and the ISBN number when this information was included.

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RESUMEN.—En este bibliografía se incluyen disertaciones recientes de interés a los etnobiólogos. Por cada uno se da el número de la página donde se halla el resumen en Dissertation Abstracts (D.A.), y el número de encargar un ejemplar de la disertación de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106-1346 USA (teléfono: 313-761-4700 o 800-521-3042; desde Canada 800-343-5299).

RÉSUMÉ.—Cette bibliographie comprend quelques dissertationes recentes d'interet aux ethnobiologistes. Chez chaqu-une on donne le número de la page où se trouve le résumé dans Dissertation Abstracts (D.A.), et le número de commander un exemplaire de la dissertation de University Microfilm International, P.O. Box 1764, Ann Arbor, MI 48106-1346 USA (telephone: 313-761-4700 ou 800-521-3042; de Canada 800-343-5299).

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## BOOK REVIEW

**Psychedelics Encyclopedia.** Peter Stafford. Berkeley, CA: Ronin Publishing, Inc. (Box 1035, Berkeley, CA 94701), 1992. (Third edition). Pp. iii, 91, and 420. $24.95. ISBN 0–914171–51–8.

In this significantly expanded third edition of *Psychedelics Encyclopedia,* Peter Stafford has offered much additional and interesting material. The earlier editions were excellent sources of information much of which were difficult to find elsewhere, but this third edition provides an incredible amount of new material as well as what the earlier editions offered. Among the additions may be cited an update of scientific research, particularly chemical research, a discussion of changing social and political considerations concerning psychoactive substances, an obituary of leaders in the study of psychoactive plants and materials and other aspects bringing the story up–to–date.

Those who have used and benefited from Stafford's earlier editions will find this third one a welcome source book of a fast changing social, political, and scientific topic. This edition includes material from the biological, psychological, physiological, medical, cultural, and sociological aspects of psychoactive drugs and their use. Its outstanding characteristic lies in its ability to strike a balanced emphasis on the popular and the scientific or technical points of view on psychoactive elements, without prejudiced exaggerations.

At the price asked, the amount of information in this volume is indeed a bargain.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, MA 02138

## BOOK REVIEW

**Farmers, Hunters and Colonists: Interaction between the Southwest and Southern Plains.** Katherine A. Spielmann, editor. Tucson: The University of Arizona Press (Conference Proceedings), 1991. Pp. xii, 220. 16 figures; 10 tables. $35.00 U.S. (clothbound). ISBN 0–8165–1224–8.

The papers in this book were presented at a conference on Pueblo–Plains relationships, held at Rancho de Taos, New Mexico, in 1987. The basis for these discussions is the archaeology and history of modern New Mexico, western Texas, and southern Oklahoma during the period from A.D. 1200 to 1600, with one contribution (by F. Levine) taking the topic into the mid–nineteenth century. The authors wrestle with economic and ecological relations between ethnic groups which had strikingly different, though interrelated subsistence and settlement systems. Simply put, Puebloan farmers traded surplus maize and some manufactured goods to more mobile Plains groups for dried bison meat, hides, and other goods. The ecological differences between these neighboring areas would make such trade attractive and possible. The authors go beyond this, however, to examine whether one of these groups had a social or economic advantage over the other, whether the need for food was more important than the need for social relationships and exotic goods, and how deeply the availability of traded food and goods affected local economic and social strategies. Some recent work in this area emphasizes climatic, ecological, and nutritional factors in weighing the differences between the two areas, and these arguments are dealt with here in articles by J. Speth, Spielmann, and D. Snow. Ecological frameworks used to describe interspecies relationships (mutualism, parasitism) are often invoked here, showing the extent to which the authors perceive sharp edges between these groups.

Other authors (J. Habicht–Mauche, C. Lintz, T. Baugh, D. Wilcox), emphasize the impact of social and historical influences on the region, noting the formation of supraregional trade networks, the migration of Athapaskan groups into the

area, the social meaning of exotic goods for ritual and status displays, and even the potential for world systems–style core and buffer zones to explain the dynamics of these relationships.

These approaches are not exclusive, as seen particularly in the Speth and Wilcox papers. The internal references within this set of papers demonstrate the productive possibilities of continuing dialogue between cultural ecologists and postprocessualists, who place less emphasis on environmental variables in explaining cultural change. The focus on nonmarket, nonhierarchical economic systems in this book provides an important contribution to economic anthropology beyond the Plains and Southwest. Individual chapters, the summary chapter (by Spielmann), index, and bibliography were all carefully prepared, making this book much more than a typical volume of conference proceedings.

Katherine M. Moore
Department of Behavioral Science
Bentley College
Waltham, MA 02154

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## SHORT COMMUNICATION

# ETHNOBOTANY, DISTRIBUTION, AND CONSERVATION STATUS OF *Ticondendron incognitum* IN NORTHERN OAXACA, MEXICO

GARY J. MARTIN
*Department of Anthropology*
*University of California*
*Berkeley, CA 94720*

and

SERGIO MADRID
*Estudios Rurales y Asesoria, A.C.*
*Escuela Naval Militar No. 420*
*Colonia Reforma*
*Oaxaca, Oaxaca, México 68050*

The description of new species and genera of plants is the bread-and-butter work of tropical plant taxonomists, but finding a new family is a rare event. Recently, two Costa Rican botanists named a new species of cloud forest tree, *Ticodendron incognitum* Gómez-Laurito and Gómez P., the sole member of a new genus and a new family, Ticondendraceae (Gómez-Laurito and Gómez P. 1989, 1991), placed in the Fagales (Hammel and Burger 1991). The tree had puzzled botanists from Mexico to Costa Rica for many years, but evidence from forestry and ethnobotanical research in Oaxaca, Mexico suggests that local people of the Sierra Norte had discovered its identity, utility, and local distribution long ago.

The data presented here are derived from two independent studies carried out between 1985 and 1992 in the northern Sierra of Oaxaca. One of us (GJM), aided by local collectors, conducted an inventory of useful plants in indigenous communities of the Sierra Norte. Ethnobotanical data were recorded for more than 5,000 specimens of plants in seasonal evergreen, cloud, pine-oak, and tropical deciduous forest (de Avila and Martin 1990; Martin and de Avila 1990). Most of the collections were made in a Mixe-speaking community, Totontepec, and in a Chinantec-speaking community, Santiago Comaltepec.

The other co-author (SM) coordinated an inventory of timber species in the cloud forests of Santiago Comaltepec as part of a larger forestry project in the state of Oaxaca. Working with local Chinantec-speakers, he measured the distribution, density, height, and diameter of trees along a transect from 500 to 2,500 meters, sampling a total of 210 sites. For purposes of analysis, this altitudinal range was split into four strata: (1) from 500–1,000 meters above sea level; (2) 1,001–1,500 meters; (3) 1,501–2,000 meters; (4) 2,001–2,500 meters. The sampling sites were spread more or less evenly across these strata.

## DISTRIBUTION

In the cloud forests of Santiago Comaltepec, *Ticodendron* trees were found between 850 and 2,150 meters above sea level, with the densest populations occurring between 1,100 and 1,400 meters. This agrees with the altitudinal limits for the species throughout its geographical range: according to Hammel and Burger the tree is found from 500 to 2,400 meters, being most common between 750 and 1,500 meters (Hammel and Burger 1991:89, 91).

Of the total of 210 sites, *Ticodendron* was detected in 102, distributed in the following manner among the four strata: (1) 5 sites; (2) 38 sites; (3) 47 sites; (4) 12 sites. Of a total of 4,508 trees corresponding to more than 30 genera measured in the inventory, 258 were individuals of *Ticodendron,* confirming it as one of the most abundant species of the cloud forest.

The trees were separated into three size classes, roughly correlated with age. Size classes were based on the diameter at breast height (dbh): small (young) individuals with a dbh of 10–20 cm.; medium (middle–aged) individuals of 20–30 cm.; large (adult) individuals of more than 30 cm. The average density, height, and diameter of trees in these classes are given in Table 1.

In their original description, drawn from Costa Rican and Panamanian collections, Gómez-Laurito and Gómez P. gave the range of tree height as 7–20 meters, and the diameter range as 0.40–0.80 meters dbh. The average heights observed in the Comaltepec cloud forest fall within this range, but the average diameters are less than half the Central American dimensions, even though the Oaxaca measurements were taken at 1.1 meters, a slightly lower level than most dbh evaluations.

TABLE 1.—Average density, height, and diameter of three size (age) classes of *Ticodendron incognitum* in the cloud forest of Santiago Comaltepec.

| Size class (Age) | Average density (trees per hectare) | Average height in meters | Average diameter in meters |
|---|---|---|---|
| Small (Young) | 4.9 | 11.2 | 0.11 |
| Medium (Middle–aged) | 6.5 | 15.6 | 0.21 |
| Large (Adult) | 17.3 | 20.6 | 0.46 |
| Population Average | 28.7 | 17.9 | 0.35 |

## ETHNOBOTANY

Our ethnobotanical collections demonstrate the importance of making sterile specimens when no fertile material of a given species is available. Prior to learning the identity of *Ticodendron incognitum,* we had collected vegetative material

of the tree in Comaltepec and Totontepec, and had puzzled over its identity. After recognizing the species in the 1989 publication by Gómez-Laurito and Gómez P., we encouraged local collectors to search for fertile material. Some of the resulting specimens had fruit, which enabled us to verify the tentative identification, and to provide more data on the little known Mexican populations of this species.

From these collections and from further interviewing, we learned that the Mixe name is ***almendras kup,*** (almond tree), and the Chinantec name *'ma$^{L}$ 'u'$^{H}$ gwii$^{LH}$*, (squirrel peach tree).[1] Both names make mention of the green, fleshy drupes of *Ticodendron,* which to the Mixe resemble the fruits of *Terminalia catappa* L. (Combretaceae) (called *almendras* in local Spanish) or, in the eyes of the Chinantec, rosaceous fruits such as peaches and cherries. One of the Central American common names given by Gómez-Laurito and Gómez P. is *duraznillo* (little peach), which is reminiscent of the Chinantec name.

The Mixe use the tree trunks as roofing beams *(horcones)* for house construction. Both the Mixe and the Chinantec consider it an excellent firewood; it is said to burn like oak *(Quercus)* wood, one of the most esteemed fuels. The Chinantec note that the fruits are eaten by squirrels, and large numbers of the gnawed endocarps can be found on the forest floor.

## CONSERVATION STATUS

On a walk through the cloud forest near the community of La Esperanza, Comaltepec, many felled trees of *Ticodendron* can be observed. The path is covered with fresh leaves, evidence of the firewood cutters who have worked in the area. The villagers say that they must go increasingly further away from the village to find trees; they have now arrived in the high-density zone between 1,100 and 1,400 meters.

Although the current effect of firewood cutting on *Ticodendron* populations in the Sierra Norte is probably minimal, social and economic changes in the state of Oaxaca could lead to increased exploitation in the future. In the markets of the central valley of Oaxaca, large quantities of oak *(Quercus* spp., Fagaceae) and alder *(Alnus acuminata* Kunth, Betulaceae) are sold daily as firewood (Martin 1992). Much of the wood is harvested by impoverished Mixtec speakers from mountain villages to the west of the valley, and the local supplies are rapidly disappearing. If easily accessible populations of hardwoods become depleted, what will be chosen as an alternative fuel source?

The Chinantec of the Sierra Norte, blessed with communal lands that extend across a broad range of ecological zones, have produced and marketed diverse agricultural and forest products for centuries. Will they add to their repertoire of productive activities by beginning to cut hardwoods from the cloud forest? If so, *Ticodendron* may be one of the first trees to feel the bite of the chain saw. Many valuable hardwoods such as *cedros* (various species of Meliaceae) and *aguacatillos* (various species of Lauraceae) would bring a higher price as timber, but machinery and technology are lacking to pull the massive trunks up precipitous slopes. Firewood brings a lower price, but transport is relatively simple when the wood is cut to size.

Apart from *Ticodendron,* the cloud forest trees most heavily harvested for firewood correspond to two species that were found to be relatively abundant in the forest inventory: *Pseudalmedia oxyphyllaria* J.D. Sm. (Moraceae), and *Calyptranthes chytraculia* L. var. *americana* McVaugh (Myrtaceae). Various species of *Quercus,* from higher up on the mountain, are also prized. Unlike some shrubby species in the temperate dry forest that are used as a source of fuel, these trees branch only near the crown. This morphology requires that the whole tree by chopped down when harvesting the wood, rather than selective pruning of branches.

The Chinantec are relatively unconcerned about the felling of these trees for firewood, and perhaps they have good reason. They have observed that, because of the quantity of the fruit fall, gaps are quickly filled by saplings, and the population regenerates. Yet direct harvesting is not the only danger. Slash–and–burn agriculture is destroying an increasing amount of primary forests as coffee cultivators prepare fields for planting corn, beans, chiles, bananas, and other subsistence crops. The heat from fires quickly destroys fruits littered on the ground and the emergent seedlings. When the agricultural plots are abandoned, secondary vegetation quickly regenerates, but the Chinantec say that *Ticodendron* and other primary forest trees do not return.

## SPECIMENS

Hammel and Burger (1991:92) cited four specimens from Oaxaca, from three different localities. In the expanded list that follows, a number of new collections are cited, all from the three previously known localities. The herbaria are cited using the standard abbreviations from Index Herbariorum, a standard botanical reference. The condition of each specimen is noted as sterile (st) or fruiting (fr); no flowering material has been collected yet in Oaxaca.

MEXICO, OAXACA: Municipio de San Miguel Chimalapa, Cerro Salomón, 1,850 m, 21 Aug. 1986 (fr), Wendt et al. 5380 (MO); Municipio de Santiago Comaltepec, La Esperanza, 1,600 m, 30 Sep. 1987 (st), López Luna 49 (MEXU, MO, UC); Municipio de Santiago Comaltepec, La Esperanza, 1,600 m, 8 Jul. 1990 (fr), López Luna 656 (CAS, MEXU, MO, NY, TEX, UC); Municipio de Santiago Comaltepec, La Esperanza, 1,600 m, 29 Apr. 1991 (fr—old fruit collected beneath tree), López Luna 694 (F, K, MEXU, MICH, MO, NY, TAES, TEX, UC, US); Municipio de Totontepec, 2 km SW de Totontepec, 1,900 m, 17 June 1986 (fr), Torres & Téllez 8620; Municipio de Totontepec, 1,900 m, 8 Sep. 1986 (st), Rivera Reyes 440 (MEXU, UC); Municipio de Totontepec, 1,900 m, 12 Apr. 1987 (st), Rivera Reyes 721; Municipio de Totontepec, 1,900 m, 11 Mar. 1990 (st), Rivera Reyes 1387 (MEXU, UC).

*Notes on the collectors and their collections.*—Thomas Wendt, collections manager at Louisiana State University, has worked extensively in Chimalapas, an area of seasonal evergreen, cloud, and pine–oak forest situated in the northeastern corner of Oaxaca state near Chiapas. Working with Zoque–speaking collectors, he focused on the woody vegetation of this previously little known zone, which includes one of the last reserves of tropical forest vegetation in Mexico. The

Zoque collaborators had seen *Ticodendron* previously, but did not know if it had a local name, or if it was used in the community. These same collectors were able to give Zoque names to the majority of forest tree species they observed.

Ricardo López Luna and Jose Rivera Reyes worked as collectors in the ethnobotanical survey supervised by Gary Martin. Ricardo López L. also participated in the forestry inventory carried out by Sergio Madrid. They are continuing to make voucher specimens of useful plants in their communities, and are seeking flowering material of *Ticodendron*.

Rafael Torres and Oswaldo Téllez are botanists from the National Herbarium of Mexico, housed in the Instituto de Biología of the Universidad Nacional Autónoma de México. During their extensive collecting in the state of Oaxaca, they discovered fruiting material of *Ticodendron* in the Sierra Norte.

## NOTES

[1]Superscript letters refer to *L*ow, *M*edium, and *H*igh tones; additional detail on Chinantec and Mixe transcription can be found in Anderson (1989) and Schoenhals and Schoenhals (1965).

## ACKNOWLEDGEMENTS

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## BOOK REVIEW

**Amazon—the Flooded Forest.** Michale Goulding. London: BBC Books, and New York: Sterling Publishing Co. (387 Park Avenue, South, New York, NY 10016), 1989. Pp. 208. $24.95 U.S. (15.00 pounds sterling). ISBN 0-8069-7476-1.

Written by a young man with 12 years of experience in fieldwork in the Amazon, including studies in 25 rivers, this book must be recommended to all who have no first-hand knowledge of the region but who are desirous of learning about it without the usual fanfare that encumbers much of the popular and semipopular literature that is flooding our markets today. In addition to being aimed at the educated popular market, there is much in the book that will be of interest to scientifically oriented students, scholars, and even seasoned scientists.

The book is divided into 10 chapters: (1) Time on the Amazon; (2) Floods; (3) Flight in the Forest; (4) Feet in the Forest; (5) Rafts of Life; (6) Lakes; (7) Pyramids of Predation; (8) Beaches and Banks, (9) Lower Amazon; and (10) Frightened Forest. There is an adequate dictionary.

If I were to choose a most important of the ten excellent chapters, it would be Chapter 10. Although small in number of pages, it presents one of the most potent considerations and practically stated discussions of the rampant destruction of rain forests that I have seen in a long time, mainly because it sets the picture against biological and geological backgrounds.

Would that we could have more such intuitiveness and practical books on the great region of the Amazon.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, MA 02138

## BOOK REVIEW

**Vine of the Soul: Medicine Men, their Plants and Rituals in the Colombian Amazonia.** Richard Evans Schultes and Robert F. Raffauf. Oracle, AZ: Synergetic Press, Inc., 1992. Pp. iv, 288. $22.95 (paperbound). ISBN 0-907791-24-7.

Similar in format to the masterpiece photographic essay *Where the Gods Reign: Plants and People of the Colombian Amazon* (Schultes 1988), *Vine of the Soul* is in many ways a companion volume. Almost none of the 160 impressive, well chosen photographs in the present work appeared in *Where the Gods Reign*. A quote from my review of that book (Van Asdall 1989) is equally true here: "The numerous photographs are at once spectacular, beautiful, fascinating, and of excellent quality." A large percentage of these are of *payés* (medicine men), and the plants, paraphernalia, and preparations associated with their art. Photographs of forest,

rivers, waterfalls, and other scenes of natural splendor are appropriate in this context because medicine men regard them as "abodes of spirits." Other photographs show sacred dances, art, and architecture, and rituals associated with hunting and fishing. The contributions of second author, Robert F. Raffauf, give insight into the biodynamics of *Banisteriopsis caapi,* (Malpighiaceae) "vine of the soul" (from the Quichua name, *ayahuasca)* and other "plants in cosmic communication."

Following the format of its companion volume, each of the photographs is accompanied by an extended commentary and a quotation from the writings or lectures of some of the anthropologists, explorers, ethnobotanists, and others who have worked in the Colombian Amazonia. Although some of the quotations date from the early 1900s or before, many are from studies of the last three decades, e.g., those of Michael J. Harner, Walter F. Lewis, Memory P.F. Lewis, Tommie E. Lockwood, Timothy Plowman, Melvin J. Shemluck, and Gerardo Reichel-Dolmatoff, to whom the book is dedicated. These singularly appropriate commentaries and quotations are, in and of themselves, lessons in ethnobotany. These texts and photographs are so well suited to one another, each complementing and elucidating the other, that the media seem destined to blend giving each of the facing pages an all but unified presentation—a manifestation of the authors' vision and a tribute to the layout artists. *Vine of the Soul* is thus both a work of art and an ethnobotanical workshop.

Both the Foreward (by Ghillean T. Prance) and the Introduction present interesting background material. Features not found in the companion book but which are welcome additions here are an Epilogue (by Michael J. Balick), a Glossary, and an Index to Quotations, giving complete bibliographic citations to all the accompanying quotations including those examples noted above.

Since most of these photographs were taken between 1941 and 1961, it is probable that because of acculturation of the indigenous people, habitat destruction, and extinction or near extinction of species, only a handful of comparable photographs could be taken today. How fortunate we are that Professors Schultes and Raffauf have shared these treasures with us and that Synergetic Press has offered them to us in book form at such a bargain.

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Willard Van Asdall, Past Editor
*Journal of Ethnobiology*
4479 N. Summer Set Loop
Tucson, AZ 85715

# BOOK REVIEW

**A Naturalist in New Guinea.** Bruce M. Beehler. Austin: University of Texas Press, 1991. Pp. 251. $26.95 (hardcover). ISBN 0–292–75541–4.

Europeans have been fascinated by the remarkable flora and fauna of the island of New Guinea for centuries, beginning with the first importations of plumes of its birds of paradise in the 1500s. Bruce Beehler is representative of the new breed of naturalists who go there to conduct intensive, long–term field research rather than cursory collecting expeditions. Beehler has spent a total of almost five years in New Guinea, spread over eight visits beginning with his 1974 study of bird of paradise courtship behavior, but increasingly focusing on ecological topics.

Following many technical publications, his book is intended for general audiences, offered as ''lay introduction to the island's natural history and a sort of catalog of the things naturalists do when out in the forest'' (p. 12). The styles of presentation is episodic, ''a more–or–less chronological narrative based on [his] own experiences'' (p. 12), with numerous related line drawings accompanying each chapter and a separate section of color plates. Interspersed among the field stories recounted are illuminating examples of how research problems can be redefined in the field. For example, while pursuing the question of why some bird of paradise species are monogamous and others polygynous, Beehler found he had to study their food resources as well, resulting in a realization that birds of paradise are ''more than just a group [42 spp.] of beautiful birds adorning New Guinea's rainforest ... [They] are critical for the dissemination of seeds of rainforest plants and are thus an important force in the regeneration of the Papuan environment'' (p. 139).

Beehler's insightful reflections on his work and experiences are relevant to regions far beyond New Guinea, and he is especially effective at disabusing the reader of simplistic notions. Thus, despite the fact that his main ornithological interest is in some of the world's most spectacular fauna, he cautions that ''[the] real jungle, most of the time, appears dull and dark. Much of each day the forest is silent and there is not a bird to be seen for love or money. Perhaps that is why for so many decades the rainforest has received little attention from the world at large. The rewards are hard–won'' (p. 205).

For the ethnobiologist reader, there is much to learn and enjoy in Beehler's book, but one glaring omission is continually evident. While he periodically refers to his local field assistants, and argues for increased training of ''promising indigenous naturalists'' (p. 243), nowhere in the book does Beehler indicate that he learned anything from them. ''When food acquisition is concerned, the New Guineans leave nothing to chance—this is not sport, after all'' (p. 216): all the more reason to suppose that their folk biological knowledge has remained a vast resource inexplicably untapped by this otherwise meticulous and keen observer.

Terence E. Hays
Rhode Island College
Providence, RI 02908

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# ABSTRACTS

*of presentations (contributed papers and poster sessions)*
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**Mary J. ADAIR,** University of Kansas, Museum of Anthropology, Spooner Hall, Lawrence, KS

## PREHISTORIC AGRICULTURE IN THE CENTRAL PLAINS: CURRENT RESEARCH AND FUTURE DIRECTIONS

To date, the earliest evidence for domesticates in the Central Plains is marshelder *(Iva annua* var *macrocarpa)* from Early Woodland deposits dated ca. 500 B.C. Corn *(Zea mays),* squash *(Cucurbita pepo),* gourd *(Lagenaria siceraria),* sunflower *(Helianthus annuus* var *macrocarpa),* beans *(Phaseolus vulgaris),* and tobacco *(Nicotiana* sp.) appear in the following cultural periods, such that by A.D. 900, an agricultural economy is recognized. Initial research, which focused primarily on chronology, sought to identify specific cultigens and to document their distribution throughout the Central Plains so that a relative importance on agricultural crops could be established for various cultural periods. A refinement of this chronology and a better understanding of economic patterns are currently underway. Efforts are underway to direct date all reported early cultigens as well as those with questionable cultural context. Stable carbon and nitrogen isotope studies may evaluate the relative dietary importance of maize. An explanation of the variability within the maize remains themselves, also a current research focus, involves the analysis of curated collections, ethnographic collections, and modern Native American garden varieties. While these topics will continue as research for some time, future directions will be focused on elucidating the significance of various cultigens beyond the subsistence role. Ways in which this information may be gathered are discussed.

**Natalie P. ALEXANDROVICH,** Republic Byeloruss, Institut Istorii ANB, Franciska Skorina, 1, Minsk, 220072, Republic Byelorussia

## ANIMALS AS THE TOTEMS OF AN ANCIENT BYELORUSSIAN POPULATION

Amulets made from bones, horns, and ceramics are widely represented archaeological materials. The most ancient amulets are little ducks made from either elk horn *(Alces alces* L.) or ceramics. Amulets made from bones and teeth, with holes and grooves for lacing, are known from many archaeological sites.

It is important to emphasize that amulets of different totems, such as beaver (*Castor fiber* L.), bear (*Ursus arctos* L.), various birds, and carnivores are found. The most common totems are bears, beavers, martens (*Martes martes* L.), polar foxes (*Alopex lagopus* L.), wolves (*Canis lupus* L.), badgers (*Meles meles* L.), wild boars (*Sus scrofa ferrus* L.), and grass-snakes (*Natrix natrix* L.). The totems of domestic animals appear later in the archaeological record. Amulets made from the teeth of domestic pigs have been recovered from early pheodalic sites from southeast Byelorussia (Nisimkovichi). Animal totems occupied an essential position in the life of the slavic tribes of Byelorussia. As documented in archaeological materials, totemism began in the paleolithic and was restricted to middleaged individuals in cultic ceremonies.

**Carlos ALVAREZ del CASTILLO, Alberto VILLA KAMEL, and Alfredo NAVA DELGADILLO,** Escuela Nacional de Antropología e Historia, México C.P., 04460, México

**ETHNOBOTANICAL STUDIES OF THE USES OF FIREWOOD IN A NAHUATL GROUP IN GUERRERO, MEXICO**

In this paper we assess the ethnofloristic resources of the basin of the Balsas Medio, Guerrero, which were used by the Nahuatl indigenous group. The Nahuatl are spead over the central section of the state of Guerrero in small villages of less than 3000 inhabitants each, including Xalitla, Ameyaltepec, S.J. Tetelcingo, S. Agustin Oapan, and S. Fco. Ozomatlan. Wood was used for firewood (domestic and ceramic firing), as well as for the manufacture of handicrafts.

The following species have been identified as primary vegetation in Guerrero: deciduous tropical forest (BTC) with dominance of burseras, BTC with dominance of columnar cactus known as *noxtli (Neobuxbaumia mezcalensis)*, and BTC with the palm *Brahea dulcis (zoyatl)*. Secondary vegetation is mainly composed of xerofitic brushwood. To estimate the production potential of some useful wood species, sampling was carried out focusing on *Acacia galeotti, espino blanco,* which is one of the species held in high esteem as a fuel (domestic), *cuajiotes (Bursera* spp.), which is used for handcrafts, and *noxtli (N. mezcalensis)* that is used to make beds and to roof houses. *Acacia galeotti* produced a volume of firewood of 25 $m^3$ per hectare, while *Bursera* spp. yielded 20 $m^3$ per hectare and *noxtli* 5 $m^3$ per hectare.

**Enrique ANGULO,** Huaca Pucllana, Miraflores, Lima, Peru (5480 Wisconsin Ave., Chevy Chase, MD)

**ALTERNATIVE STRATEGIES FOR RAIN FOREST EXPLOITATION IN SOUTH AMERICA**

Uncontrollable deforestation of South American rainforests resulting from irrational and ignorant state policy decisions seriously impacts the economies and public health of indigenous populations. Coca *(Erythroxylon coca)* cultivation and the polluting effects of its transformation into PBC and cocaine, along with the consequences of its marketing for the societies taking part, is the most obvious

recent example. When the effects of cattle raising and temporary agriculture and the resulting alteration of the rainforest are considered, it is evident that the only real management alternative is reforestation with native species and native crops. Where such biotic communities generate naturally produced products, primary forests must be protected along with the established biotic variables that would favor their maintenance. This would be nothing new for the native societies living in the forest, who are being pushed to the margins. Unfortunately, their knowledge, which has developed through the centuries, is not taken into account. The Biological Expositive Unit at Huaca Pucllana and its archeozoological and archeobotanical laboratories are being created to record and rescue information regarding the management and knowledge of plants and animals used by prehispanic societies—their nutritional, medicinal, and industrial uses, and their symbolic iconographic use in the arts. This research is carried out in an ecological context that is essential to providing governments, financial institutions, and people an understanding of the perils of continuing with the present deforestation rate.

**Kurt F. ANSCHUETZ,** Museum of Anthropology, University of Michigan, Ann Arbor, MI 48109

**CORN IN THE FLOW OF LIFE: FURTHER CONSIDERATION OF HOPI CONCEPTS OF *Zea mays***

Existing anthropological analyses of Hopi concepts of corn have been hindered by the narrowness of our own interpretive constructs, which emphasize the materialist concerns underlying the themes of nourishment and reproduction. As a consequence, we have a poor ethnological comprehension of the central role that corn concepts play in conditioning how the Hopi understand and occupy the Tusayan Washes. In this paper, I show how our anthropological understanding of Hopi corn metaphors can be made more complete by explicating the fundamental importance of the association between Hopi concepts of corn and water.

**Alejandro de AVILA B.,** Instituto Tecnológico de Oaxaca, Apdo. Postal 1378, Oaxaca, Oax. C.P., 68000, México

**PLANTS IN CONTEMPORARY MIXTEC RITUAL: *Juncus, Nicotiana, Datura, and Solandra***

The Mixtec community of Coicoyan de las Flores is located in the Sierra Madre del Sur in westernmost Oaxaca State, in southern Mexico. With an altitudinal gradient from about 1000–3000 m above sea level, the lands of the community are ecologically quite diverse. The local flora includes over 1000 species of vascular plants. In this paper I describe the ritual use of four species, two of which are cultivated in home gardens *(Nicotiana* and *Datura),* while the other two grow in the fields *(Juncus)* and forests *(Solandra)* above the village. Bundles of rush *(Juncus)* are used in the rain-petition ceremony, celebrated on certain mountain-tops on April 24th (San Marcos). Locally grown tobacco is associated with magical casts for love and harm. *Datura* and *Solandra* were traditionally ingested as hallucinogens

for divination, particularly after the loss or theft of property. Seeds of a fifth, unidentified species, possibly *Turbina,* were used similarly. The latter plant does not grow locally, but the seeds were brought in from the Pacific lowlands. I review pre–Columbian codices and sixteenth century Colonial sources to document the ancient use of rushes and *Datura* in Mixtec culture. I also trace the etymology of the Mixtec names of the five species in Coicayan and compare them with terms used in other Mixtec languages to indicate their salience in Mixtec ethnobotany. Finally, I compare the rush bundles with the similar bunches of pine and copal resin employed by the Mixe and Chontal peoples of Oaxaca, and I relate the use of *Nicotiana, Datura,* and *Solandra* to the knowledge of hallucinogenic Solanaceae elsewhere in Mesoamerica.

**Bradley C. BENNETT,** The New York Botanical Garden, Institute of Economic Botany, Bronx, NY

**PLANTS AND PEOPLE OF ECUADOR'S AMAZONIAN RAINFORESTS: LESSONS AND NEEDS FOR SUSTAINABLE DEVELOPMENT**

Ethnobotany has helped develop many important Amazonian products including rubber, quinine, chocolate, and curare. Native plants remain vital resources of the Amazon's indigenous people. Yet many are poorly known by science. The Shuar use 196 species for food and 245 species for medicines. The Quichua use 90.9% of the species found in a one hectare plot. Collectively, Amazonian Ecuador's native people use nearly half the region's 3500 species. These figures, representing our present knowledge, probably underestimate the true importance of plant resources.

Ethnobotany not only identifies plant resources but also the indigenous processes of using them. Agroforestry and resource extraction are new names for century-old techniques. Indigenous people plant, protect, or collect plant resources. Combinations of these techniques with the region's diversity of plant resources create sophisticated systems of forest use. Some of these systems offer alternatives to destructive practices currently used.

Much needs to be done before we can realize ethnobotany's full potential for protecting the plants and people of the Amazon. First, we must continue to identify the plant resources. Both rainforests and cultures are disappearing rapidly. The coexistence of intact cultures and intact forest is exceedingly rare. Second, we must evaluate the economic potential of forests and promote the marketing of nonwood products. Third, we should promote new uses for traditional products. *Carludovica palmata* R. & P. is the source of the famous "Panama" hat. Yet, it is as important in traditonal societies for food, shelter, and basketry. Many development efforts in Amazonian have been cultural and ecological disasters. There are several ways we can avoid the pitfalls of previous projects. Promotion of multiple species is one way. Much of the past failure is due to the reliance on a single resource. Multiple-use species are especially desirable. A second imperative is that we first promote products at the local level. As these develop we can expand to regional, national, and international markets. Grassroot support within communities will help assure success and promote benefits to community members.

**Antonio BIANCHI,** Yia Sommariva 5, Verona, 37131, Italy and
**Samorini GIORGIA,** Natural History Museum of Robereto

**PLANT USE IN THE AYAHUASCA COMPLEX IN NORTH WEST AMAZONIA**

Contemporary use of Ayahuasca in Amazonian populations involves the knowledge of the properties of many other plants. Some of these plants are strong vegetal hallucinogens, others could influence the course of the Ayahuasca intoxication, while others could have only a fragrant activity. We are reviewing 77 plants, from different sources, to evaluate the ethnological, chemical, and pharmacological data supporting their use in the Ayahuasca complex. The goal of this kind of work is to establish, when possible, the level of study regarding any plant and to give prominence to the importance of further fieldwork.

**Zlatozar BOEV,** Bulgarian Academy of Sciences, National Museum of Natural History, Boulevard Russki, Sofia 1000, Bulgaria

**RAPTORS AND OWLS (FALCONIFORMES ET STRIGIFORMES - AVES) FROM ARCHAEOLOGICAL EXCAVATIONS IN BULGARIA**

All archaeozoological data of diurnal and nocturnal raptors (vultures, eagles, falcons, hawks, and owls) from Bulgaria are presented. A total of 4685 bones and bone fragments of birds were collected from 29 archaeological sites in the country. In 16 of them, 77 bone remains (1.64%) of raptor birds are established. Sites cover a very long period—from the Upper Paleolithic (ca. 31,900 years B.P.) to the Medieval Ages (twelfth century A.D.). The species composition is wide—21 species, 17 raptors and 4 owls. The most numerous are the griffon vulture and the towny owl, registered in four settiements. The golden eagle, the eagle owl, the goshawk, and the buzzard are established in three sites. Some interesting rare birds, such as Lammergeier and Bonelli's eagle, are proved for two settlements. Among other species are the black vulture, lesser-spotted eagle, saker falcon, hen harrier, honney buzzard, hobby, kestrel, red-footed falcon, little owl, and long-eared owl. The Lammergeier, black vulture, and (?) red-footed falcon are extinct and 12 (13) species are endangered and rare species in the recent Bulgarian avifauna. All these wild birds shared the settlements of ancient man since deep antiquity. Some of them have been used, but a great number were indifferent species-companions of man during his historical development in Bulgaria.

**Carol B. BRANDT,** Zuni Archaeology Program, Pueblo of Zuni, P.O. Box 339, Zuni, NM 87327

**PRESERVING TRADITIONAL CROPS IN RURAL INDIGENOUS COMMUNITIES: AN EXAMPLE FROM THE PUEBLO OF ZUNI**

In the last one hundred years the Pueblo of Zuni in west-central New Mexico has been confronted with a reduction of traditional lands, the introduction of a cash economy, and the destruction of valuable farmland. Crops that once sustained the Zuni people are now threatened with extinction. To prevent the loss

of these resources, the Traditional Zuni Crops Project was undertaken in the Fall of 1991. The goals of this project were to document crop diversity on the Zuni preservation and to collection donations of traditional Zuni crops for preservation in a tribal seed bank. Fifty households were interviewed concerning crops grown from year to year in their fields and gardens, as well as the source of seed stock for each crop variety. The survey found that those traditional crops that are more common in the Zuni community are those that are closely associated with the Zuni religious activities and ceremonial calendar. Attitudes towards sharing seed through a tribal seed bank were also documented, revealing the role of seed in many of the winter ceremonies. These data emphasize that traditional crops are perceived by the community as an important cultural resource, integral to Zuni cultural identity. Insights such as these are an important preliminary step in designing a local seed bank program that will be able to serve the community in ways that the people recognize as being appropriate and useful.

**Cecil H. BROWN,** Department of Anthropology, Northern Illinois University, Dekalb IL 60115

**LEXICAL ACCULTURATION IN NATIVE AMERICAN LANGUAGES**

This study identifies and explains cross–language patterns in ways Native American languages have named new plants and animals and other objects and concepts encountered in contact situations. This is achieved by surveying words for 75 items of Occidental culture (e.g., rice, sugar, sheep, and horse) in vocabularies of a large number of American Indian languages. Such words are either loanwords (e.g., from Spanish into Latin American Indian languages) or terms manufactured from native vocabulary (e.g., literally, ''little maggots'' for rice in a number of North American Indian languages). Research suggests, for example, that languages that are heavy adopters of loans for these items have histories involving significant bilingualism of speakers, while languages that show considerable use of native terms for such items do not have such histories. Another finding is that some items of acculturation, such as hen and rooster, tend to be labeled by native terms across languages, while other items, such as cow and horse, tend to be labeled by loanwords. This may be related to the possibility that words for items such as cow and horse have been used in interactions with donors in the past to a greater extent than have words for items such as hen and rooster. Elucidation and explanation of these and other findings will contribute to several areas of interest relating to ethnobiology including sociolinguistics, language universals, language and culture change, and social histories of individual Native American groups.

**Carmen BURCH,** Connecticut College, Box 5427, 270 Mohegan Ave., New London, CT 06320

**FUZZY FIELDS AND CATCHALL CATEGORIES: THE CENTRALITY OF INDETERMINANCY IN TO MAKI SWIDDENING PRACTICES**

Ethnoecological research methods long have been deemed problematic for producing static classifications—ones that fail to capture the dynamic and pro-

cessual aspects of human–environment interactions. This paper asks: Is this intrinsic to the methodology or due to the ethnographer's primary emphasis on identifying attributes that clearly distinguish discrete entities and categories? In fact, has the "native point of view," a view often more inclusive in what it considers and encodes, been thoroughly explored in relation to classifications? Based on fieldwork with the To Maki Toraja, upland forest cultivators living on the island of Sulawesi (Indonesia), this paper looks first to To Maki classifications of garden types. While contrasts between garden types are readily made, in practice the To Maki are more attentive to the fluidity of boundaries between types and catchall categories—the points at which classifications get "fuzzy." The paper then focuses on the *pa'lak,* the most variable garden type identified by the To Maki. Although the *pa'lak* is indeterminate in its formation, cropping pattern, and life–span, as an element in the swiddening regimen this "fuzzy" field is central in allowing the To Maki to position themselves to respond quickly to uncertain future states. In this the *pa'lak* seems key in the overall operation of the To Maki subsistence economy. By looking more carefully at the penumbra of meanings associated with classifications, along with the points of transition between categories rather than just points of contrast, ethnoecological methods can be salient in identifying major environmental problems faced by subsistence cultivators and serve as important guides in deciphering subsistence histories.

**Robert A. BYE, Jr.,** Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, A.P. 70–614, Ciudad Universit., 04510, DF, México, and **Peter KEVAN,** Department of Environmental Biology, University of Guelph

**ETHNOBIOLOGY OF MADRONE BUTTERFLY *(Eucheira socialis* [LEPIDOPTERA: PIERIDAE]) OF MEXICO**

The madrone butterfly *(Eucheira socialis)* is an unusual insect in that it has primitive morphological characteristics yet the larva exhibits advanced behavior (i.e., quasisocial). The lifecycle of the insect is strictly associated with the five species of *Arbutus* or madrone tree of the Sierra Madre Occidental and the Trans–Neovolcanic Mountains of Mexico. Up to 600 larvae and pupae are housed in the two–walled bag composed of double–stranded threads. Up to 20 bags are found on a single tree. The larvae forage only at night from September to May. Historic and anthropological literature make reference to the use of larvae and pupae as food as well as to the manufacture of flags, bandages, and containers from the silk–like bag. Contemporary use of this black butterfly is limited to northwestern and central Mexico. *Iwiki* (as it is known to the Tarahumara Indians of Chihuahua) is consumed by the older people but rarely by the young. The fat–rich pupae, which develop in May, may have been an important protein and calorie source for these traditional subsistence agriculturalists during the end of the dry season and prior to the start of the cultivation cycle. Bags of larvae tied to trees suggest that the Tarahumara practice husbandry with this insect. The mythology of moths (and dark colored butterflies) in Chihuahua may be rooted in Mesoamerican traditions based upon insect metamorphosis. The over exploita-

tion of the pine-oak forests and the imprudent destruction of madrone trees threaten the existence of this butterfly while neglect of the management and use of the madrone-*iwiki* association by indigenous peoples signals possible loss of cultural information.

**Charles E. CANTLEY** and **Leslie E. RAYMER,** New South Associates, 4889 Lewis Rd., Stone Mountain, GA 30083

## WETLAND HABITATS: SOCIAL AND ECOLOGICAL RESPONSES TO THE ENVIRONMENT BY EARLY SOUTHEASTERN INDIANS

Archaeological investigations undertaken in the interior uplands of the southeastern Piedmont and Appalachian regions find that the Archaic Period sites tend to cluster in and around swamp environments. Traditionally, archaeologists have interpreted this pattern solely on the basis of the subsistence component of these cultural systems. Our investigations of sites in these localities suggest that other variables interact with the subsistence component in determining swamp margin prehistoric settlement patterns. This paper will explore both the economic and social components of hunter-gathered systems and their interaction with the ecological parameters of wetland environments. We hypothesize that Archaic Period hunter-gatherers established their settlements in and around upland swamps in order to fulfill basic subsistence needs and to aid women in their dual roles as child-care providers and plant food collectors.

A brief examination of 14 modern hunter-gatherer groups suggests that women in these societies make significant subsistence contributions and are probably nursing children for most of their adult lives. Given the high energetic costs of continuous lactation and the importance of women's subsistence contributions, it would have been advantageous to Archaic groups to locate their settlements where women could effectively and efficiently perform both food gathering and child care tasks. A review of the botanical and ethnobotanical literature for the southeast suggests that swamp habitats represent such localities. Swamp environments in the study area are characterized by high species diversity and productivity and are rich in edible and medicinal plants. Swamp margin camps would have allowed women easy access to a wide variety of economically important woody and herbaceous plants. This easy access would minimize women's energy expenditures on plant gathering forays, and would enable them to use this "saved" energy in the care and nurturing of their children. Our research shows that hunter-gatherer mobility-settlement strategies may vary along several ecological and social dimensions. As such, our investigations may provide important new information for addressing not only which cultural components are present on swamp edge sites but the organizational and structural characteristics of these sites as well.

**C. Wesley COWAN,** Cincinnati Museum of Natural History, 1720 Gilbert Ave., Cincinnati OH 45202 and **Bruce D. SMITH,** Department of Anthropology, NMNH MRC112, Smithsonian Institution, Washington, D.C. 20560

## HABITATS AND HISTORICAL RECORDS OF WILD *Cucurbita* GOURDS IN EASTERN NORTH AMERICA

Free-living *Cucurbita pepo* gourds have been documented in disparate areas in the temperate eastern woodlands since the first few decades of the nineteenth century. Until recently, however, little attention has been afforded these populations, and specifically, their potential role in the evolution of domesticated forms of pepo squashes has been minimized. The paper focuses on the botanical history of free-living gourds, examines the availability of cultivar ornamental gourds to American gardeners, and summarizes habitat information for contemporary populations in several areas in the east. Important morphological measurements from both contemporary free-living and cultivar pepo gourd populations as well as archaeological specimens are compared. These combined data suggest that free-living *Cucurbita pepo* gourds are ancient members of an eastern flora, and probably played an important role in the evolution of domesticated squashes.

**D.S. DECKER-WALTERS, T. WALTERS,** Fairchild Tropical Garden, 11935 Old Cutler Rd., Miami, FL 33156, **C. Wesley COWAN,** Cincinnati Museum of Natural History, 1720 Gilbert Ave., Cincinnati, OH 45202, and **Bruce D. SMITH,** Department of Anthropology, NMNH, MRC112, Smithsonian Institution, Washington, D.C. 20560

## CHARACTERIZATION AND INTERPRETATION OF ALLOZYME PROFILES IN WILD POPULATIONS OF *Cucurbita pepo*

Allozyme data were collected from 20 wild populations of *C. pepo* ssp. *ovifera* recently discovered in Louisiana, Oklahoma, Missouri, Arkansas, Illinois, and Kentucky. Comparison of these data to similar data generated for populations in Texas *(C. pepo* ssp. *ovifera* var. *texana)* and Tamaulipas, Mexico *(C. pepo* ssp. *fraterna),* Mexican landraces *(C. pepo* ssp. *pepo),* and cultivars representing both major genetic lineages *(C. pepo* spp. *ovifera* var. *ovifera* and *C. pepo* ssp. *pepo)* revealed a distinct allozyme profile including the characteristic allele *Idh-2m* for the non-Texas U.S. populations. Although about 50% of these populations exhibited signs of limited, and, in most cases, recent introgression from cultivars, only one population, which was represented by a single fruit from Kentucky, deviated sufficiently from the typical allozyme profile to be considered a possible escape. Both populations from Louisiana possessed *Idh-3o,* an allele otherwise restricted to the Texas population. All U.S. populations were distinguished from Mexican and domesticated *C. pepo* by having relatively large within-population frequencies at *Aat-le-*. Populations from northeastern Mexico also exhibited an unique allozyme profile with affinities to both of the major lineages. In conclusion, the allozyme data reveal that genetic evolution has occurred independently over thousands of years in at least three disjunct ecogeographic habitats (northeastern Mexico, Texas, and the midwestern United States) within the range of *C. pepo.* Furthermore, cultivars were selected independently at least twice, once from populations in Mexico and once from populations in the United States.

**Lin DUNBAR,** University of North Carolina, 617B Hibbard Dr., Chapel Hill, NC 27514

**THE LIVE OAK: SYMBOL OF THE SOUTH CAROLINA LOWCOUNTRY**

The live oak is a central, multivalent symbol in the imagery of the South Carolina lowcountry. Though the meanings of the tree are both public and private, the live oak is used to express, communicate, and reinforce an aristocratic tradition. Within the lowcountry's natural, cultural, and societal history, the live oak is a dramatic public symbol that serves a leading role in the region's presentation of self. While many individuals acquiesce to the tree's public image, others have personalized and transformed it into a statement of counter-hegemony. This paper explores the image of the live oak, emphasizing its counter-hegemonic meanings.

**Susan D. deFRANCE,** Department of Anthropology, Florida Museum of Natural History, University of Florida, Gainesville, FL 32611

**ECOLOGICAL IMPERIALISM IN THE CENTRAL ANDES: ZOOARCHAEOLOGICAL RESEARCH OF SPANISH COLONIAL SETTLEMENT, MOQUEGUA, PERU**

Spanish colonialization of the Peruvian Andes during the sixteenth century was accompanied by dynamic changes in agro-pastoral production as European methods of farming and livestock rearing were imposed on the existing Andean system. In contrast to other areas of Spanish colonial settlement, the Andes were the only American center of prehistoric large mammal domestication. Spanish introductions of Old World domesticated animals for both subsistence and industrial purposes led to the emergence of unique patterns of colonial animal use. The economic and environmental repercussions of the establishment of these species persist to the present. One colonial enterprise that depended on animal resources for both food and industrial needs was the prolific wine industry that was established in many of the coastal river valleys. This paper explores the role and impact of Spanish-introduced fauna in the settlement of the central Andean coastal plain through a zooarchaeological analysis of four colonial wineries or *bodegas* from the Moquegua Valley of far southern Peru. The analysis provides data on animal use from the sixteenth through the nineteenth centuries in both industrial and domestic settings. These data are used to assess the effect of Spanish-introduced fauna on the peoples and habitats of the central Andean region.

**Yvonne EVERETT,** Department of Forestry and Resource Management, 145 Mulford Hall, University of California, Berkeley, CA 94720

**THE KITUL PALM—ETHNOBOTANY OF *Caryota urens* IN HIGHLAND SRI LANKA**

*Caryota urens,* known as the *kitul* palm in Sri Lanka, is a native rainforest species. It is also one of the most common trees in the multi-species perennial

homegardens of the highlands. Along with the palmyra in arid areas and coconut in the coastal zone, *kitul* is one of three palms traditionally tapped for nectar from which sweet syrup, sugar, and various alcoholic beverages are prepared. The syrup and sugar have a special richness akin to maple products known in the United States, and are highly valued for culinary and medicinal purposes in Sri Lanka.

Tapping palms is the domain of an occupational caste of ''toddy tappers'' who traditionally divide the yield with palm owners. This paper focuses on the tappers' knowledge and management of *kitul* palm, its products, and tapping and processing activities. The ecological and economic importance of developing markets for *kitul* products in relation to forest and landscape conservation in highland Sri Lanka is discussed. This paper is based upon the author's interviews with tappers, study of *kitul* yields, and participant observation while living in villages during dissertation field research on home gardens in highland Sri Lanka in 1989–91.

**Catherine S. FOWLER,** Department of Anthropology, University of Nevada, Reno, NV 89557–0006

**NORTHERN PAIUTES AND THE BIRDS OF STILLWATER MARSH, NEVADA**

Northern Paiute people have lived in the area surrounding Stillwater Marsh in western Nevada for at least 1000 years. During that time, they have observed the seasonal migrations of numerous species of waterfowl and shore birds, come to understand their nesting and food habits, sorted visitants from residents, learned to duplicate their calls, and so on. They have also witnessed the destruction of this important bird habitat in recent years due to upstream water diversion. This papers reviews something of the ethno–ornithological knowledge of this group, including the role that waterfowl played in their subsistence cycle and in their broader orientation to their lands and world. Ethnographic data are drawn from the extensive knowledge of Wuzzie George, who witnessed the transition of her people from native foragers to forced farmers in the latter part of the nineteenth and early twentieth centuries.

**Jose GONZALEZ RODRIGO,** Universidad Autónoma Metropolitana, Iztapalapa, D.F., 09340, México, and **Regina Leal GUEMEZ,** Unidad Iztapalapa, Iztapalapa, D.F., 09340, México

**DEVELOPMENT OF AN EXPERT SYSTEM FOR THE STUDY OF THE MANAGEMENT OF NATURAL RESOURCES IN INDIGENOUS COMMUNITIES**

There is in ethnobiology a marked interest in the study of the management of natural resources in peasant indigenous communities from an holistic outlook. In this case, it is important to emphasize the role that peasant economies play for the development of modern societies. Therefore, it is essential to have methodological tools which allow us to perform investigations in these com-

munities. The objective of this paper is to introduce a model for the management of natural resources in a peasant Nahuatl community performed by using software to create expert systems. With this model, we can obtain an outlook which regards economics, politics, religious, and social characteristics, including their relationships, in the studied community. This model is built from investigations in Santa Catarina del Monte, Texcoco, located in the Valley of Mexico.

**Leslie M. Johnson GOTTESFELD,** Department of Anthropology, University of Alberta, Edmonton, Alberta, T6G OR2, Canada

## ABORIGINAL USE OF FIRE FOR VEGETATION MANAGEMENT IN NORTHWESTERN BRITISH COLUMBIA

The Giksan and Wet'suwet'en peoples of northwest British Columbia occupy the upper drainage of the Skeena River and the western headwaters of the Fraser River. They live in a region of diverse topography, vegetation, and climate transitional between the northwest coast and the boreal interior. The land is mountainous and, except for alpine areas, heavily forested. I have investigated the use of fire by the Gitksan and Wet'suwet'en for vegetation manipulation.

Berry patch burning was the most important traditonal vegetation manipulation. Montane black huckleberry *(Vaccinium membranaceum)* and lowbush blueberry *(Vaccinium caespitosum)* patches were burned in the fall to stimulate growth of new stems and production of berries, while preventing invasion by other shrub species and young conifers. Low elevation berry patches might also be burned in the spring. Soapberries *(Shepherdia canadensis)* are also reported to have been managed by burning at times. Burning of berry patches is reported to have been done by groups of women, or by groups of men on the way to hunting mountain goats in areas above the berry patches. Berry patches were owned, and were located within house group territories. Only the owners had the right to burn their area or to arrange for it to be burned.

Berry patch burn intensity was controlled by utilizing appropriate seasonal and diurnal timing, knowledge of weather conditions, and fuel loading. Maintenance of berry patches by burning was discontinued in the 1930s and 1940s because of fire suppression by the British Columbia Forest Service. Spring burning on south facing slopes, village sites, and garden sites was also practiced, and continues to the present. It occurs in aspen, pine, or grass-dominated seral communities, or cottonwood floodplain forest, and is intended to control brush and encourage growth of grass or garden vegetables.

**P. Heeth GRANTHAM, Jessica BOOHER, Bill WEYLMAN, and Joel BARNES,** The School for Field Studies, Marine Mammal Biology and Conservation, Baja, California Sur, Mexico. (Grantham: 305 Overhill Road, Baltimore, MD 21210)

## IDENTIFICATION OF FISH SPECIES OFF THE SHORES OF ESPIRITU SANTO, LA PARTIDA, AND LOS ISLOTES ISLANDS AND THEIR RELATIVE IMPORTANCE TO THE CALIFORNIA SEA LION *(Zalophus californianus)* AND THE FISHERMEN OF LA PAZ

Fishing techniques and catch composition of artisenal fishermen were established from Espiritu Santo, La Partida, and Los Islotes Islands of Baja California Sur, Mexico, between the months of September and November 1991. Twenty-two samples from drift nets, seine gillnets, and hook and lines yielded 35 fish species. Relative number, weight, and catch frequency per species were calculated to identify those most important to fishermen. Barred pargo *(Hoplopargus guentheri),* broomtail grouper *(Mycteroperca xenarcha),* and bronze-striped sea chub *(Kyphosus analogus)* were found to be most important, followed by greybar grunt *(Haemuoln sexfasciatum),* pacific goldeneyed tilefish *(Caulolatilus affinis),* and red snapper *(Lutjanus peru).* Four of the 35 species caught by fishermen matched prey species of the California sea lions *(Zalophus californianus)* inhabiting the Los Islotes rookery. Of these species, only *Caulolatilus affinis* had a high importance to fishermen. This species is a minor part of the sea lion diet, suggesting minimal human/sea lion competition. However, seasonal changes in fishermen's catch and sea lions' diet may create competition at other times of the year. This study provides baseline data for future management plans to sustain artisenal fishing and a healthy sea lion population in the Bay of La Paz.

**Robert J. HARD,** Division of Behavioral and Cultural Sciences, University of Texas at San Antonio, San Antonio, TX 78249

**ECOLOGICAL FACTORS INFLUENCING REDUCED MOBILITY AND THE ADOPTION OF AGRICULTURE IN HUNTER/GATHERER GROUPS**

Recent advances in the cultural ecology of hunters and gatherers suggest that there are particular ecological characteristics which encourage trends toward reduced residential mobility and increased use of cultigens. Comparisons of a number of prehistoric trajectories indicate the potential for identifying common ecological factors which influence the adoption of agriculture and reduced mobility.

**David G. HILL,** Center for Energy and Environment, University of Pennsylvania, Philadelphia, PA

**ENERGY USE AND MANAGEMENT IN A NEPALI HILL VILLAGE**

Energy resources utilization is a major interface between humans and the environment. This paper presents a case study of energy use and management in a village in the middle hill regions of Nepal. Effective external assistance is based first upon an understanding of the structure and genesis of local resource management systems, and then upon a practical inquiry into how this knowledge translates into action. Ethnobiologists have a role to play in outlining for various agents the dynamics of the interface between humans and biomass resources.

I set out with the objective of understanding local perceptions and knowledge of the energy system, and evaluating alternatives. While biomass resources are the predominant energy source, I observed that local conversation, when not directed by outside inquiry, focused more frequently on the topic of money than

it did on the forest or other biomass resources. Certainly indigenous awareness and knowledge of the factors that shape the biomass use system are extensive, and rarely well understood by outsiders, but I took this observation as an indication of local priorities and realities. A respected informant suggested at one point that rather than weighing and measuring of wood loads and other biomass flows I should devote more investigative effort towards current and historical local politics.

Villagers in the study area are highly aware of resource use and management issues and conflict. Forest tenure is dominated by patterns established many decades ago, that do not reflect current forestry law. Vested interests, practical conservatism, and limited resources devoted to policy implementation and monitoring all play a part in forming this gap, which is probably common, between the de facto and de jure situations.

While more than 95% of the total energy supply in the study area comes from biomass resources, an investment in a micro hydro–electric plant, that would replace imported fossil fuels used for lighting and agricultural processing, is currently the most feasible and attractive energy management option. This finding is based on the relative opportunity costs of capital and energy resources in the village, as well as consideration of the social and political factors that shape the current biomass use system. The research does not suggest that opportunities to improve the productivity, equity, or sustainability of biomass resource use and management do not exist, or are not needed. It is critical to acknowledge, however, that even when biomass plays a predominant role in a particular energy system, investments in the resource must be weighed against other options.

Many countries are deeply involved with policy issues concerning biomass energy resources. Governments gave the challenge of increasing their role of facilitating and empowering development, rather than serving primarily as sources of first and last recall or as conduits for foreign aid. Forest policy makers must evaluate the relative costs and benefits of common versus private property management, and the nature of interactions between local systems and external agents. This research uses an ''ethnoenergetic'' approach to further the understanding of these and related topics.

**HUANG, Xiecae (HUANG, Se-zei),** Guangxi Institute for Drug Control, Guangxi, China

## A PRELIMINARY STUDY OF *Tiancha* (SWEET-TEA) OF GUANGXI PROVINCE, CHINA

*Tiancha* (Sweet-tea) is the commercial name for the sweet leaves of several species. It is an ethnomedicine often used in Guangxi, chiefly for hypertension and diabetes. In recent years, it is the main material to make drinks *(tiancha),* and is also one of the ingredients of a Chinese patent medicine. It has been purchased as a commercial drug in China. The author has carefully identified the sample of commercial drug and specimens. It has been found that the botanical origins of *tiancha* (Sweet-tea) in Guangxi are four species. These are: *Rubus*

*suavissimus* S. Lee (Rosaceae), commercial name *yaoshan-tiancha; Lithocarpus polystachyus* (Wall.) Rehd. (Fagaceae), commercial name *baise-tiancha; Engelhardia roxburghiana* Wall. (Juglandaceae), commercial name *guiping-tiancha;* and *Mycetia sinensis* (Hemsl.) Craib (Rubiaceae), commercial name *longzhou-tiancha.*

**Neil C. HUGHES,** Department of Anthropology, NMNH, MRC 112, Smithsonian Institution, Washington, D.C. 20560

**FAUNAL EVIDENCE OF THE EFFECT OF THE SPANISH CONQUEST ON INDIGENOUS PROCUREMENT ACTIVITY AT MANAGUA, NICARAGUA**

A small faunal collection excavated by salvage archaeology in Managua, Nicaragua, was divided into prehistoric and historic assemblages based on the introduction of European domesticated species. Faunal data provide evidence that the preconquest indigenous population practiced a broad-based procurement strategy which included 23 taxa and 32 minimum number of individuals (MNI), with biomass representing four vertebrate classes (mammals, fish, reptiles, amphibians). Also urn burial and burned human bones in a midden context are indicative of mortuary as well as sacrificial and cannibalistic rites. This pattern was replaced by a faunal assemblage which contained no human bones, and although it included 20 taxa and 15 MNI, biomass was concentrated in just a single class (mammals) of European domesticates. However, the small size of the faunal collection, the limited areal coverage it represents, and a possible sample bias create difficulties in fully or accurately discerning the nature of prehistoric faunal procurement and ritual activities. In Nicaragua, which is largely unknown archaeologically, it is nevertheless important to ask these questions within an appropriate analytical framework, and to arrive at a tentative hypothesis which can be confirmed by further study. The identification of the collection and the establishing of allometric values by the Zooarchaeological Laboratory of the Florida Museum of Natural History has provided such a framework. The resulting paper, therefore, represents a first systematic assessment of faunal remains in Nicaragua and proposes that changes in faunal resource exploitation strategies point to a radical change in the structure of procurement activity resulting from the Spanish conquest. This hypothesis is supported by ethnohistorical accounts of organized exploitation of terrestrial and aquatic fauna, ritual human sacrifice, and cannibalism.

**Eugene HUNN,** Department of Anthropology, University of Washington, Seattle, WA 98195

**THE USE OF SOUND RECORDINGS AS VOUCHER SPECIMENS AND STIMULUS MATERIAL IN ETHNOZOOLOGICAL RESEARCH**

The importance of collecting voucher specimens in ethnobotanical research is well recognized. However, collecting zoological vouchers—especially of large vertebrates—may prove beyond the capacity of many field projects. I describe the potential of field tape recordings of animal vocalizations as both vouchers and as stimulus materials for eliciting native terms and associated cultural data.

Sound recordings can be at least as reliable for species documentation as photographs, study skins, or skeletal specimens, and such recordings are easily copied and edited for use in naming tasks with consultants at a later time. Basic equipment and procedures involved in making and using such recordings are also described.

**Timothy JOHNS, Gaetan M. FAUBERT, Vivian FRANKLIN,** School of Dietetics and Human Nutrition and Institute of Parasitology, McGill University, McDonald Campus, St. Anne de Bellevue, Quebec, H9X 1CO, Canada, and **R.L.A. MAHUNNAH,** Institute of Traditional Medicine, Dar es Salaam

**ANTI-GIARDIAL ACTIVITY OF LUO GASTROINTESTINAL REMEDIES**

Plants used to treat gastrointestinal ailments by the Luo of the Lake Victoria region of Kenya and Tanzania were identified in field surveys. Brine shrimp bioassays of 30 species were conducted in the field with the purpose of developing a means of predicting anti-giardial activity. Crude methanolic extracts of 44 samples were tested in an in vitro assay against the protozoan parasite, *Giardia lamblia.* Samples active below 500 ppm include *Albizia coriaria, Comoiphora africana, Microglossa pyrifolia, Ozoroa micronata, Rhus natalensis, Solanum nigrum, Sonchus schweinfurthii, Vernonia brachycalyx,* and *Ximenia caffra.* Several of the plants that show activity against *Giardia* contain saponins or steroidal alkaloids. Crude extracts and purified fractions of these plants were tested for antimolluscicidal activity against *Biompharia glabrata,* an organism sensitive to saponins.

**Elaine JOYAL,** Department of Botany, Arizona State University, Tempe, AZ 85281

**ETHNOECOLOGY OF *Sabal uresana* (ARECACEAE) IN SONORA, MEXICO**

*Sabal uresana* is one of the most economically important wild plant species in the Sonoran foothills of northwestern Mexico. Its populations are thought to be over-exploited, leading to its recent listing as ''rare'' in Mexico. Its distribution, natural history, use, and ''management'' are poorly known, however. Preliminary data on the use and management of *S. uresana,* both my observations and those of the indigenous and mestizo communities that use it, are presented here.

Different size-class palms within the same population may have distinct names and uses. People travel up to a day to obtain *cojoyos,* newly-unfolding leaves, which are valued for weaving mats, baskets, and hats. The summer monsoon season is the major harvest time for *cojoyos. Palmas,* fully-expanded leaves, are used for thatching and for broom manufacture. They are harvested only when they are readily accessible, during the fall or spring dry season. In addition, all palm leaves are harvested during the full moon to insure their longevity. Only dead palms are cut for logs. Burning of palm stands is common. My continuing research is quantifying palm populations and investigating local management of *S. uresana* for possible *in-situ* conservation. The potential impact of an increasing demand for *S. uresana* products by tourists needs to be assessed.

**Jay Bahadur Singh KARKI,** Social Science Division, International Rice Research Institute, Los Banos, Manila, Phillippines, and **Madhav B. KARKI,** Institute of Forestry, Pokhara Campus, Pokhara, Nepal

**POTENTIALS OF HOME GARDENS IN IMPROVING THE SOCIO-ECONOMIC AND ECOLOGICAL CONDITIONS IN THE KATHMANDU VALLEY OF NEPAL**

In this study the floristic composition of home gardens and the utilization of these species in relation to their cultural origin, ecology, and socioeconomic factors were analyzed. The study found that home gardens play an important role in garden economics and sustainability of farming systems. Two types of home gardens were identified—permanent and temporary. The subsystems were subsistence home gardens, and commercial home gardens. Mixed home gardens (permanent), opportunity home gardens, and shared home gardens were also identified. Permanent home gardens are strongly and traditionally linked with their evolution, and there is strong desire to sustain them, whereas temporary home gardens can be left fallow if no suitable tiller is found. These home gardens have a high floristic richness, providing families with numerous products to satisfy various needs: of 230 species reported; 70% were used as nourishment, 20% as fodder and fuel wood, and 10% had secondary usages. However, the species with highest densities and frequencies were the food plants. This paper will also describe the total litter fall from the tree canopy and its contribution to soil fertility. The exchange of plants and knowledge of plants by the families in the communities have made home gardens more floristically homogeneous. Home gardens are also a place of agricultural experimentation in which all the family participates.

**Jay Bahadur Singh KARKI,** Social Science Division, International Rice Research Institute, Los Banos, Manila, Philippines

**ANALYSIS OF FARMING SYSTEMS AND SOCIOECONOMIC FACTORS RELATED TO THE INDIGENOUS AGROFORESTRY SYSTEM IN THE MID HILLS OF NEPAL**

This study analyzed farming systems and socioeconomic aspects of an indigenous sustainable management system in the mid hills of Nepal, and focused on land-use patterns and people's perception of, and attitutes toward, the systems. Primary data were obtained through interview and observation. The traditionally developed farming systems that were identified were home garden only, home garden and paddy, home garden and upland, and home garden, paddy, and upland. Analysis of farming systems focused on the dominant cropping pattern—single component, double component, and multiple cropping systems. The predominant land use systems associated with farming in the area included three traditional, locally developed agroforestry systems—agrisilviculture, silvipastoral, and agrisilvipastoral. Subsystems were: multipurpose trees on farmland, shelter for plantation crops, wind breaks and homestead garden,

fodder orchard, tree grazing system and protein bank, and grazing and browsing system. Farmers showed favorable attitudes towards locally-evolved agroforestry systems, although several expressed openness to some exchange. Perception was significantly related to socioeconomic characteristics (i.e., education, income, and farm structure). Farmers' attitudes were related to education, occupation, income, household size, and farming system. Age, sex, caste, religion, farm size, and family work force had no bearing on perception or attitude. Recommendations based on the study were grounded on using an approach characterized by refinement or improvement of the existing land use system rather than radical transformations from the outside.

**Margarita KAY,** University of Arizona, 8861 E. Calle Bolivar, Tucson, AZ 85615

**THE COLUMBIAN EXCHANGE OF MEDICINE**

Columbus's travels to the New World occurred at the time when there was widespread interest in learning about new medicinal plants to treat illness. One of Columbus's stated purposes for his voyage to find a new route to the Indies was to obtain ''spiceries:'' ''I believe that there are in it many plants and many trees, which are worth a lot in Spain for dyes and for medicines of spicery.'' He had read the *Travels of Marco Polo* and was going to look for the plants he had read about. In hs first report Columbus writes ''. . . what causes me the greatest grief in the world, when I see a thousand sorts of trees that each have their own kind of fruit, . . . and a thousand sorts of plants, the same with flowers; and of the whole lot I only recognized this aloes, much of which I have also ordered brought aboard to bring to Your Highness.'' ''(Morison 1963). He was in fact no botanist; he did not see aloe, it was agave.

For Columbus's second voyage, Dr. Diego Alvarez Chanca was appointed official physician to the fleet. Chanca described native healing and natural history in a letter which stands as the first ethnography of the New World (Ybarra 1894, 1906; Tio 1966; Paniagua 1977). He also made wrong identifications, although with aloes he said it was ''not of the same kind as the one we are acquainted with in Spain . . .'' In New Spain, Cortex continued the medical ethnographical tradition. From letters we learn of his respect for Aztec herbs and also of his urgent request for bringing plants from Spain. The Columbian exchange of medicine has begun. By the 1540s, the Franciscan friar Bernard de Sahagun was collecting information on Mexican native beliefs of diseases and plants that cured them. In 1571 Franciscan Hernandez, called the ''Pliny of the New World'' was sent by Philip II of Spain to study the natural history of the new world, a study which occupied his team until 1576. He described some 3076 plants, many of which were used as medicines. His descriptions emphasized morphology of the roots and leaves, making it difficult to provide positive botanical concordances. Monardes in Seville reported (orig. 1577) on the medicinal plants that he had received from New Spain, plants that next appeared in Johnson's revision of John Gerard's *The Herbal* (orig. 1633).

As New Spain was explored, missionized, or colonized, descriptions of the natural history followed that included each area's healing plants. And so continued a process of medical acculturation wherein Old World and New World exchanged knowledge of each other's healing materials. This paper will consider the ethnopharmacology that resulted from the introduced and indigenous plants.

**Constantine V. KREMENETSKI,** Institute of Geography, Russian Academy of Sciences, Lab of Palaeogeography, Staromometny Lane 29, Moscow 109017.

## BRONZE AND IRON AGE ENVIRONMENTS IN THE LOWER DNIEPR REGION

A pollen analytical study of Kardashinski peat bog, situated near the mouth of the Dniepr (46 degrees 31'N, 32 degrees 37'E), combined with carbon-14 dating, made it possible to reconstruct the history of vegetation of the region for the last 8000 years. Up to 4200 BP the flood-plain and sandy terraces of the Dniepr were covered by forests composed of broad-leaved trees—birch, and especially pine. Later, forest areas diminished due to climate changes and human impact. In the lower part of the Dniepr Valley the largest forest and steppe areas extended northward to the Black Sea shoreline. In the vicinity of the Kardashinski bog, many settlements of bronze-smelters were discovered, dating to 3500-2900 BP. The location of these Bronze age settlements is well understood from the palaeobotanical viewpoint. At the beginning of the Iron Age, when Scythian tribes and Greek colonies appeared northward to the Black Sea, the intensity of land-use seriously grew. In the middle of the fifth century BC "the father of history," Herodotus, visited the Greek city Olbia on the north shore of the Black Sea (46 31'N, 31 40'E). In his description of the Black Sea region Herodotus mentioned a forest "Hylaea," near the Dniepr River (History, IV, 18, 19). Later Hylaea was mentioned by other ancient authors. Palynological research taking into account geobotanical and soil data allow the placement of the Hylaea forest on the left bank of the Dniepr on flood-plain and sandy terrace locations corresponding to the ideas of both historians and botanists. In settlements of the Scythian period charcoal of *Pinus, Betula, Quercus,* and *Corylus* were found. In rural settlements of Greek period near the city of Olbia (400 BC-AD 400) charcoals of *Ulmus, Fraxinus, Quercus, Tilia, Pinus, Populus,* and *Alnus* were found. This correlates very well with the composition of pollen spectra of the diagram of the Kardashinski bog for the same period.

The existence of forests in the river valleys is also demonstrated by archaeozoological data. In Scythian and Greek settlements in addition to the bones of steppe animals *(Saiga, Equus, Bos)* the bones of forest animals *(Cervus elaphus, Capreolus capreolus, Alces alces, Felix silvestris)* were found. In rural settlements dated to AD 0 bones of *Putorius putorius* L., which lives in oak forests, were found. In the rural settlement of Petuhovka, of the same age, the bones of *Apodemus flavicollis* Melchior, an inhabitant of broadleaved forests, were found.

By AD 1000 the composition of forests in the lower part of the Dniepr Valley was impoverished. So in Slav and Tartar settlements (AD 1100-1200) *Quercus* char-

coal dominates, and *Pinus* charcoal was not found. This correlates with the pollen data. Forest areas were seriously diminished after AD 1200 due to climatic deterioration and human impact.

**Joseph E. LAFERRIÈRE,** Arnold Arboretum of Harvard University, 22 Divinity Ave., Cambridge, MA 02138.

**POPULATION GROWTH AND THE ORIGIN AND INTENSIFICATION OF AGRICULTURE**

For any given state of cultural–environmental relations, food productivity is highest at medium population densities. Population growth would tend to increase beyond optimum levels but not to starvation densities. Populations would have a tendency to accept minor innovations or borrowings which might increase productivity in a short time frame but which may over a longer time period lead to population increases, thus creating an incentive for further cultural changes. Major changes which would result in large shifts in productivity would be discouraged because of short–term increases in labor costs. Changes which improve per capita productivity might result in a gradual improvement in lifestyles whereas changes requiring increased labor input would result in gradually decreasing per capita productivity. Genetic changes in resource species would have the same effect as technological innovations or shifts in time allocation. Temporary decreases in the productivity of a specific resource (e.g., crop failure due to drought) would increase the tendency toward acceptance of innovations, as would impending population decline due to depletion of nonrenewable resources. Depopulation due to war or epidemic might result in a shift toward less intensive agricultural systems. Resources amenable to enhancement of productivity would be favored over those for which opportunies for improvements are not evident. Diet breadth optimization theory predicts that cultural changes which result in increased productivity of resources previously neglected due to low efficiency might lead to broadening of the overall variability of the diet. Improvements in already preferred resources might reuslt in decreased diet breadth. The need for nutritional balance suggests an alternation of improvements in complimentary resources.

**Dosia LAEYENDECKER,** Department of Anthropology, Smithsonian Institution, NMNH, MRC 112, Washington, D.C. 20560

**ANALYSIS OF CHARCOAL SAMPLES FROM MARITIME ARCHAIC SITES IN LABRADOR, CANADA**

Charcoal and wood samples have been collected from hearths in archaeological sites along the coast of Labrador since 1968 by field crews of the Smithsonian and other institutions under the direction of William Fitzhugh. More than 2000 samples have now been analyzed. Radiocarbon dates run on these samples range from about 7000 BP to 500 BP, the earliest part of which (until about 3500 BP) represents the Maritime Archaic period. The results of the analysis are

presented by histograms showing the relative percentages of different wood taxa found in the charcoal. It is shown that spruce was available for fuel during the whole Maritime Archaic period as far north as Aillik. These data compare with the fossil record of pollen analysis. It is concluded that Maritime Archaic people lived in two different environments, in the closed spruce forest in the south of Labrador and in the open tundra in the north.

**Edelmira LINARES, Robert A. BYE, Jr.,** Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Apdo. Post. 70–614, D.F., 04510, México, and **Erick ESTRADA,** Departamento de Fitotécnia, Universidad Autónoma Chapingo, Chapingo, México

## MEDICINAL VASCULAR PLANTS IN MEXICO: AN EVALUATION OF A BOTANICAL-CULTURAL RESOURCE

Since prehispanic times, there have been inventories of medicinal plants in what is now known as Mexico. The *de la Cruz-Badiano Manuscript* (263 plants listed of which 49% are identified), written by Aztecs, is one of the earliest written documents of this nature. Civil and church authorities of early colonial Mexico also collected data on remedial plants in the *Natural History of New Spain* (3,076 plants listed of which 32% are identified) and the *Florentine Codex* (724 plants of which 52% are identified), respectively. In the 1970s, the Instituto Mexicano para el Estudio de Plantas Medicinales (IMEPLAM) compiled a national inventory which was essentially based upon earlier results of the work of the Instituto Médico Nacional. IMEPLAM reported 2,196 higher plant species distributed in 900 genera and 161 families. Based upon our review of anthropological, botanical, ethnobotanical, and ethnomedical publications and unpublished theses since 1976, the Mexican medicinal flora registry consists of 3,352 species (in 1,214 genera and 166 families) or about 15.5% of the national vascular flora. Four state inventories exist, although only 24–60% of the data on medicinal employment originated from the respective political entity. About one third of Mexico has yet to be investigated for medicinal plants; the northern arid region is the least known area. Selected plants illustrate the wealth of ethnobotanical information associated with these vegetal remedies. Nonetheless, the lack of systematic comparative ethnobotanical data, of reliable taxonomic identification, and of field and laboratory validation of effectiveness indicates the urgent need for integrated surveys of medicinal plants, especially in light of continued loss of cultural information not passed onto the younger generation. Local studies as well as national surveys (such as those by the Instituto Mexicano de Seguro Socal and the Instituto Nacional de Indigenista) will enable Mexico to evaluate the current status of medicinal plants in a realistic manner and will aid the public and government officials in planning for the maintenance and beneficial exploitation of this valuable cultural and botanical resource.

**Gary J. MARTIN,** Department of Anthropology, University of California, Berkeley, CA 94720 (94, Blvd. Flandrin, Paris 75116, France).

## WHO KNOWS?: AN EXPLORATION OF VARIATION IN MIXE ETHNOBOTANICAL KNOWLEDGE

I discuss an identification task aimed at measuring the variation in local knowledge about plants in Totontepec, a Mixe community of Oaxaca, Mexico. We prepared a set of 35 dried botanical specimens that exemplify the various use categories, lifeforms, vegetational habitats, and other ways of characterizing plants in Mixe ethnobotany. We then selected a subsample of 88 individials who represent the patterns of age, gender, education, migration, and other sociological characteristics of the municipal population. By asking these individuals to identify the set of dried botanical specimens, we were able to gauge who knew what about plants. In this paper, I offer an analysis of how age and gender correlate with botanical expertise in Totontepec.

**Stephen MAVI and N.Z. NYAZEMA,** National Herbarium and Department of Clinical Pharmacology, Harare, Zimbabwe

## RESEARCH IN MEDICINAL AND POISONOUS PLANTS: A CHALLENGE FOR THE HEALTH SYSTEM IN ZIMBABWE

The aim of this paper is to highlight our current knowledge of the medicinal uses of plants in Zimbabwe and to give pointers as to the plants that need further investigations from chemical, medicinal, and pharmacological points of view. Five hundred traditional practitioners were visited in the main centers of Zimbabwe. Plants used by traditional practitioners together with information on their uses and how they were administered were recorded. Poisonous plants commonly used by traditional practitioners were listed. Standard works published in Africa concerning traditional plant use were compared to our findings. Extensive studies have been carried out to investigate the medicinal properties of indigenous plants, their distribution, and cultivation. The aim has been to encourage conservation and cultivation of those that have been found to be of medicinal value. At the same time, effort has been made to encourage proper use of poisonous plants. These have included the following: *Securidaca longependuculata, Boophane disticha, Cassia abbreviata, Euphorbia ingens, Monadenium lugadiae, Warburgia salutaris, Gnidia kraussiana, Dioscorea sylivatica, Alepidea amatymbica, Solanum delagoense, Datura stramonium, Gloriosa superba,* and *Rauvolfia caffra.* Research on these plants may result in their utilization as either crude drugs or raw material in the manufacture of pharmaceuticals required to promote primary health care. We hope this study will contribute towards increasing the availability of essential drugs at a much reduced cost by the year 2000.

**Guillermo Luis MENGONI GONALONS,** Consejo Nacional de Investigaciones Científicas y Técnicas, Argentina (c/o Department of Anthropology, Smithsonian)

## THE LLAMA AS A MEAT PRODUCER

South American camelids, both wild and domesticated, have been considered by people to be a very important economic resource ever since prehistoric times. Although the domesticated camelids are better known as wool producers (especially the alpaca, *Lama pacos)* and as beasts of burden (the llama, *Lama glama),* they were also an important source of primary products. Among them, meat and its related products should be considered as one of the main staples for many traditional subsistence economies.

This paper discusses the importance of the llama as a meat producer, based on the study of its economic anatomy. Available meat percentages and utility indices were calculated for the different body parts of the llama and compared with those of other ungulates. The information thus generated will be useful for having a better understanding of the present use given to this animal and the history of its domestication. Certainly, economic anatomy is another dimension through which animal domestication can be studied besides the more traditional ones, such as size variation, morphological characteristics, and function.

**Pamela MCBRIDE, Julia E. HAMMETT,** and **Janet L. MCVICKAR,** University of New Mexico, Albuquerque, NM

**CORN . . . FROM CINDERS TO CHIFFON: A CINDERELLA STORY**

Little is known about the subsistence strategies of the prehistoric Sinaguan culture of northcentral Arizona. In the San Francisco Mountains, a concentrated deposit of corn and other plants remains in a volcanic cinder matrix was recently uncovered in a 1000 or more year old pit structure. An 80 liter sample was removed from the structure and taken to the laboratory. As archaeobotanists, we rarely have the opportunity to reliably evaluate our recovery methods. Because of the large volume of well-preserved material obtained from this feature, we recognized a unique opportunity to make this comparison. The cache contents were subsampled and processed using a variety of commonly used macrobotanical extraction methods. A comparison of these results produced provocative information concerning the effectiveness and efficiency of each method. Though our results are specific to cinder matrix, similar results might be expected from other matrices. These methodological insights allow us to evaluate the precision of each method.

**Mark D. MERLIN,** General Science Department, Dean Hall Room 2, University of Hawaii at Manoa, Honolulu, HA 92822

**ETHNOBOTANY AND ENVIRONMENTAL IMPACT OF THE KAVA PLANT, *Piper methysticum* (Forst. f.), ON POHNPEI ISLAND, FEDERATED STATES OF MICRONESIA**

The psychoactive *kava* shrub *(Piper methysticum)* was domesticated in the tropical Pacific, where it has been a major drug plant with significant religious, social, and medicinal value in various island societies for centuries, if not millennia. Today it is still one of the most important plants in the Micronesian culture

of Pohnpei, a high volcanic island in the Eastern Carolines. Traditionally, the root stock of this narcotic shrub has been a major offering of ceremonial tribute to high ranking individuals in the various districts of the island. Consumption of the *kava* beverage was also a traditional source of spiritual inspiration and a significant part of conflict resolution on Pohnpei. However, except for medicinal purposes, before European contact in the early nineteenth century, use of *kava* on the island was generally restricted to the chiefly class. During the twentieth century, the patterns of its cultivation and use on Pohnpei have changed dramatically. After colonial Japanese left the island, restrictions placed on local consumption were lifted, and farming and use of *kava* and its soporific beverage began to rise, with new segments of the society becoming involved. The rapidly increasing size of the human population, in combination with the nontraditional, widespread consumption of *kava* since WW II by both men and women at various levels of society, has put significant pressure on some traditional natural resource areas. Areas of native upland forest *(nanwel)* previously uncultivated are now subjected to ecosystem disturbance due to sometimes obvious, but more often clandestine patches of cultivated *kava* plants. This paper describes the evolution of contemporary patterns of *kava* consumption and cultivation. It also discusses the implications for long term soil erosion control and maintenance of biodiversity among the native forest species of Pohnpei Island.

**Sona K. MEZLUMIAN,** Institute of Zoology, Academy of Sciences of Armenia, P. Sevak Street 7, Yereva, 375044, Armenia

**HORSES OF THE BRONZE AGE OF NORTHERN ARMENIA**

We have discussed the great number of horse remains in archaeological sites in Armenia from Eneolith to the Iron Age (fourth to first millennium B.C.) in previous publications. However, investigations of Bronze Age sites of northern Armenia have exceeded all expectations. Horse remains constitute about 90% of the domestic animals at these sites. Collections of subfossil equids from the foothills and mountain regions (former collections are from lowland sites) have been essentially replenished. Thus we have the opportunity to trace morphological changes in the domesticated horse throughout Armenia. Based on craniological parameters and the size and structural peculiarities of bone limbs, there appears to have been two separate horse populations in the Bronze Age in northern Armenia. At the same time there are appreciable differences between extreme variants. The most important in our opinion is the existence of the pronounced ''breeds'' from pack-horses to graceful saddle-horses with a withers height of 138–145 cm. These data show that ancient horse-breeding traditions may be several thousand years old. This conclusion is consistent with the opinions of some archaeologists, who maintain that intensive development of horsebreeding took place in the mountain regions of Transcaucasus, rich in deposits of ore. Northern Armenia is just such a region.

**Christopher MILLER,** Institute of Ecology, University of Georgia, Athens, GA 30605

**BRAZIL NUT GATHERING IN EASTERN AMAZONIA: A SUSTAINABLE ALTERNATIVE TO DEFORESTATION?**

The Brazil nut tree *(Bertholletia excelsa)* is a forest canopy emergent in *terra firme* or upland sites in much of the Amazon Basin. Typically, 50–100 Brazil nut trees may be found together in stands or groves, called *castanhais* (sing. *castanhal);* groves are separated from each other by several kilometers. The trees bear fruits with 10–20 edible seeds, known as Brazil ''nuts,'' that are gathered and sold by collectors. Most of the nuts are exported and sold in North American, European, and other markets. Brazil nut collecting in extractive reserves may generate revenues that surpass income from rubber tapping activities; furthermore, Brazil nut gathering may act as an important wet season activity to complement dry season rubber tapping in the forest. This paper will examine the yield and density of one hectare sample plots in several *castanhais* in eastern Para, Brazil and assess the values of the nut crops. Furthermore, priorities for future research goals on Brazil nut ecology and sustainability will be examined.

**Lee A. NEWSOM,** Department of Anthropology, Florida Museum of Natural History, Museum Road, Gainesville, FL 32611, **S. David WEBB,** and **James S. DUNBAR,** Florida Bureau of Archaeological Research

**EARLY *Cucurbita pepo* FROM A FLORIDA WETSITE**

Recent excavations at the Page–Ladson (8JE591) site on the Aucilla River in Florida turned up *Cucurbita pepo* gourd seeds. Excavations of Page–Ladson have tested deposits that date from the last Wisconsin glacial phase (ca. 18,000 BP) to approximately 4000 BP. Lithic, bone, and wood artifacts from the Paleo–Indian and Archaic periods appear in late Pleistocene, early Holocene, and younger levels. The *Cucurbita pepo* seeds come from a highly organic clay stratum with *Mammut americanum* and other extinct Pleistocene fauna, but no clear evidence of human activity. One sample with gourd seeds has accelerator radiocarbon dates of 12,454±80 BP and 12,375±75 BP (NSF–Arizona AMS lab, AA–7452, AA–7453). Thus far, gourd seeds have not appeared in samples from earlier Pleistocene or more recent deposits at Page–Ladson. The Page–Ladson seeds will be discussed aong with *Cucurbita* gourd identifications from other sites in Florida.

**Steve PATTERSON,** Department of Geography, 1255 Bunche Hall, UCLA, Los Angeles, CA 90024

**PHENOLOGY IN ECOLOGY AND ETHNOBIOLOGY**

Phenology is the study of periodic biological phenomena as they are influenced by climate and weather: the flowering of plants, the migration of birds, the emergence of insects. Reports of the observation of such phenomena are scattered throughout ethnographic literature, ''The Omaha planted their squashes

at the time of the blossoming of the wild plum'' being an example. The observation of phenological correlations can yield significant ecological information. Even in today's highly technological agriculture in the U.S., phenological data provides information as yet unmatched by any bio-climatic computer model. In Montana, for example, farmers make their first spring cutting of alfalfa within 10 days after purple lilac begins to bloom, and thereby reduce their losses to the alfalfa weevil, *Hypera postica,* which emerges at that time.

Phenological observations also become incorporated in noneconomic cultural patterns, for example, in the timing of ritual occasions. According to Radcliffe-Brown, the Andamanese had a calendar of scents, based on the succession of odors through the year as different species of trees came into flower. In Yucatan the flowering of *achiote (Bixa orellana)* is considered to ''announce'' the coming of the Days of the Dead, as well as signal the time to bend over cornstalks in preparation for their subsequent harvest. Phenological observations thus are a link between ecology and culture. Such patterns and links, however, have been subject to little systematic study. This paper reviews ecological and ethnographic reports of phenology, and highlights questions and problems for future research. Specific instances of such questions which emerged during recent research on ritual and ornamental plants among the Yucatacan Maya are adduced as examples.

**QUAN, Xia,** Department of Biology, Lanzhou University, Lanzhou, Gansu Province, P.R. China

**A STUDY OF GANNAN TIBETAN'S TRADITONAL MEDICINE: HERBS AND HEALINGS**

Gannan Tibetans live in the northwestern part of China. For centuries, traditional Tibetan medicine has played an important role in the health care of the Tibetan communities of the region. Today, Tibetan medicine is still practiced as a parallel system, or in some isolated regions, as the dominant medicinal system compared to the modern medicinal system. In the medicine of the Gannan Tibetans, a number of highland herbs are employed. The methods used in processing and utilizing these plants are quite different from modern pharmacological methods of treatment. Some of the herbal medicines are very valuable in the development of cancer-killers or even AIDS-killers. In this paper, the author reports the results of a study of the medicinal system of the Gannan Tibetans. One hundred and fifty species of traditional herbal medicines are identified; their scientific names, local names, usages, and parts used are recorded. Botanical and pharmacological aspects of some plants are briefly discussed.

Gannan Tibetan Autonomous Profecture is located in the convergence of the Qingzang plateau and Loess-highland of China. With population of 5.5 million, the autonomous profecture is a major Tibetan region of Gansu Province. Traditional Tibetan medicine has a history over 1000 years old. Many centuries before the Christian era, the ancestors of Tibetans knew that distilled highland barley grains could cure injury, and that yak butter could staunch bleeding. Today, even after the introduction of modern medicine, traditional Tibetan herbal medicines

play an important role in the indigenous medicinal system, and in the daily lives of the Gannan Tibetans. In a Tibetan community, traditonal knowledge of Tibetan medicines is developed and handed down mainly in Buddhist monasteries. To maintain the precious cultural heritage, many generations old, Tibetan herbalists, practitioners, and local pharmacologists have contributed lifetimes to the practice of herbal medicine. These individuals have accumulated abundant experience with highland herbal medicines used in the treatment of illness. Unfortunately, most of the knowledge has not been shared with people outside the Tibetan world because of the influence of ''orient–mysticism'' of Tibetan Buddhism. In this paper, the author deals with the character and composition of the traditional medicines of Gannan Tibetans and tries to introduce this unique traditional medicine system to the scientific world.

**Elizabeth J. REITZ,** Museum of Natural History, University of Georgia, Athens, GA 30602

**THE SIZE OF DOMESTIC CATTLE IN COLONIAL SITES**

A significant aspect of early colonial efforts was the adaptive response in zooarchaeological studies of cattle *(Bos taurus)* remains. Measurements of cattle bones recovered from Caribbean Hispanic sites suggest that cattle were quite large at these locations. In contrast, cattle at North American colonial settings were smaller. However, early Spanish cattle appear to have been larger than later English cattle. Factors which might be involved include the harsher climates associated with English colonies compared to Spanish colonies and the different origins of livestock found at Spanish and English North American colonies.

**Irwin ROVNER,** Binary Analytical Consultants, North Carolina State University, Raleigh, NC

**USING OPAL PHYTOLITHS TO INTERPRET THE ETHNOBOTANY OF HISTORIC PERIOD SITES**

Paleobotanical applications of opal phytolith data have tended to emphasize chronologically early periods and general paleoenvironmental issues. However, several recent studies have shown that phytolith analysis is particularly well suited to ethnobotanical studies in more recent historic period sites. The decay-in-place nature of much of phytolith deposition allows for the study of micro-environmental and micro-distributional patterns of flora. Recent studies at a number of historic sites, including Monticello (VA), early Hampton (VA), Harpers Ferry (WV), among others, demonstrate a high degree of precision in identifying ethnobotanical activity. These include alteration of local floral assemblages, introduction of foreign taxa, landscape patterns of lawns and gardens, and so on.

Phytoliths were used to reconstruct the floral history of a single back yard at Harpers Ferry spanning its most recent two centuries. This reconstruction was correlated with the documented history of the contiguous house and its occupants. Phytolith data were recovered from tartar deposits adhering to domestic herbivore

teeth recovered from excavations at early Hampton, VA. Distinct differences in animal dietary patterns contributed to greater awareness of land use and livestock management practices at both the household and community levels over a period of some 150 years. Microfossil data captured in the teeth appear also to provide evidence of local water quality, e.g., increased degradation and pollution, over time.

**Irwin ROVNER,** Binary Analytical Consultants, North Carolina State University, Raleigh, NC

**PROBLEMS OF MORPHOMETRIC PRECISION AND ACCURACY IN SEED IDENTIFICATION AND ANALYSIS**

Size and shape measurements, morphometric data provided in conventional seed identification manuals and atlases, are typically based on few, if any, measurements using small—often unstated—sample sizes for each taxon. By contrast, this study used interactive computer–assisted image analysis to generate multiple measurements of size and shape on every individual in relatively large sample populations for each taxon, respectively. Included were measures of size (length, width, breadth, area, and perimeter) and shape (aspect ratio, form factor, roundness, extent, solidity, and convexity). Comparison of morphometric data of the populations tested with data presented in standard references displayed substantial discrepancies. For instance, normal range of size variation often exceeded, even far exceeded, published data. Discrepancies occurred unpredictably—sometimes at the minimum end, sometimes at the maximum end, sometimes at both ends of the range. In a few instances the ranges were so different that no overlap of size occurred. In many cases the mean size value for the large sample population fell outside the range presented in standard references. This means that more than half of a population of seeds selected at random will measure either larger than or smaller than published reference value. Similarly, comparison of seed populations at the varietal level showed very distinct ranges of variation; some narrow, some broad. Thus, if seeds of one variety are compared with a reference population of another variety within the same species, a considerable disparity of size is possible, if not probable.

Typically, archaeobotanical and paleobotanical seed populations are randomly selected, i.e., randomly deposited and recovered. This suggests that the same discrepancies noted above between the large tested populations and standard small population reference data may also operate in the analysis and interpretation of fossil seed populations. This raises some doubt, for example, about the interpretation of seeds as cultivated due to ''increased'' size if comparisons are made with data in standard reference manuals and atlases. Further, it was also noted that morphometric variation in seed populations are not necessarily normal or gaussian distributions. In such instances virtually all parametric statistical analysis, which assumes a normal distribution, may be inappropriate.

**Jan SALICK,** Department of Botany, Ohio University, Athens, OH 45710
**NON-TIMBER FOREST PRODUCTS, ETHNOBOTANICS, AND BUFFER ZONE MANAGEMENT IN THE INTERNATIONAL PEACE PARK, NICARAGUA AND COSTA RICA**

Tropical ethnobotanical studies frequently identify nontimber forest products as being a critical component of extractive reserves, buffer zones, and natural forest management. A diverse array of species can be extracted from tropical rainforests without adversely affecting plant populations. Management of these species is being attempted in the International Peace Park buffer zones. The Peace Park was remarkably preserved throughout the war, only to be battered even more furiously now by laissez-faire economic extraction and land grabbing. Buffer zone management holds some faint hope for conservation and protection of the inner preserve. Experiments and field data compare community characteristics of nontimber forest products under natural forest management, campesino management, and primary and secondary forest conditions. Campesino management appears to be the next best thing to primary forest as far as species diversity, and best yet as far as ethnobotanics.

**Enrique SALMON,** Arizona State University, Tempe, (1632 East Northshore Dr., Tempe, AZ 85203)
**EXAMINING THE TARAHUMARA PERSPECTIVE OF SACRAMENTAL CORN BEER: TOWARDS AN ETHNOGRAPHIC RE-CLASSIFICATION OF *Zea mays***

To the Tarahumara of Chihuahua, Mexico, corn is their staff of life. It is believed by the Tarahumaras that they are the children of corn. As a result, they employ as a sacramental offering, corn beer, known within the culture as *suwi-ki.* The beer is derived from the plant *Zea mays,* along with other native Mexican plants. Past ethnographers have misclassified the corn beer made from *Zea mays* as only a beverage and special food. However, John Kennedy's etic approach considered the beer within its religous context, but fell short of describing its true character. In his book on Tarahumara foods, *Rela'muli Nu'tugala Go'ame (Food of the Tarahumaras),* Albino M. Trias, a Tarahumara, emically does not include *suwi-ki,* except to mention how it is made, thus implying that the Tarahumara classify the beverage as something other than food. Based upon field research conducted by the author, who is also of Tarahumara heritage, and on Trias's book, this paper will explore the emic view of *suwi-ki,* which parallels the etic version of ''sacrament.'' The Tarahumara ritual observance of the beverage will also be explained, demonstrating its unique ceremonial and communal functions.

**Judith SCHMIDT,** New York Botanical Garden, Bronx, NY
**PLANT DYES FOR HARRIS TWEEDS**

What are the plant dyes traditionally used for Harris tweeds in the windblown North Atlantic islands of the Outer Hebrides off the west coast of Scotland? Are the same dye plants used on the mainland?

**Elizabeth M. SCOTT,** Mackinac State Historic Parks

**AT HOME THEY 'COMMONLY ATE NO PORK': OBSERVANCE OF JEWISH DIETARY RESTRICTIONS AT THE SOLOMON-LEVY TRADING HOUSE AT FORT MICHILIMACKINAC, 1761-1781**

This paper examines the evidence for adherence to Jewish dietary restrictions in one eighteenth century household in North America. Land sale records from the fur trading post of Fort Michilimackinac, in what is now northern Michigan, identify this house as one purchased in 1765 by two Jewish traders, Ezekiel Solomon and Gershon Levy. According to both the material culture and dietary evidence, the occupants of this house between 1761 and 1781 became increasingly wealthy. Documentary evidence for Solomon reveals his increasing wealth in the 1770s and his increasing involvement with the Jewish congregation in Montreal. The change in diet evident in the food remains corresponds to both factors, and it is the dietary evidence rather than the material culture which suggests the Jewishness of the occupants.

The paper presents evidence from faunal and floral remains for this household, as well as from documentary records. By comparison with contemporaneous neighboring households, the diet in the Solomon–Levy house is shown to be distinct from that of both British and French–Canadian colonists. Following F. Gerard Ijzereef's (1989) criteria for identifying Jewish and nonJewish households in eighteenth century Amsterdam, the evidence from the Solomon–Levy house at Michilimackinac may be seen to indicate greater adherence to Jewish dietary restrictions through time.

**G.K. SHARMA,** Biology Department, University of Tennessee, Martin, TN 38238–5014

***Cannabis* STUDIES IN THE HIMALAYAS**

The Himalayas are known for their wild or nearly wild populations of *Cannabis*. Botanical studies of *Cannabis* populations in their natural habitats in the Himalayas are of great significance for understanding the ecological, biochemical, and ethnomedical relationships existing in the taxon. It is suggested that a concerted, thorough investigation of this mysterious plant be made in its probable home in the Himalayas. The findings of a general survey of *Cannabis* in the Himalayas will be discussed.

**SHILIN, Hu,** Institute of Chinese Materia Medica, China Academy of Traditional Chinese Medicine, Beijing, 100700 China

**ON THE ADVANCES OF CHINESE ETHNOHERBOLOGY**

This paper deals with the advances of Chinese ethnoherbology, stressing the two aspects of traditional and multitribal characteristics. On one hand, the ''tradition'' of a science means that it has lasted for many centuries, beginning in ancient ages, is rooted in the thoughts of the population, and has been used for a long time. On the other hand, Chinese ethnoherbology is an integration of all ethnic medical systems. In other words, it contains various constituents of Tibetan, Mongolian, Uygur, Korean, and other minority systems in addition to the Chinese system which is the main part of China ethnoherbology and already has a great reputation all over the world. There are five points reviewed in this paper: (1) a new term ''ethnoherbology'' first appears in this paper; it can be defined as the scientific study of the relationship of ethnology and herbology; (2) the main systems of China ethnoherbology include Chinese, Tibetan, Mongolian, Uygur, and Korean, which belong to their own language families, necessitating the study of the relationship between languages and ethnoherbological systems; (3) the results of exploration and survey of Chinese ethnoherbology indicate that there are at least 2,000 ethnomedicinal items, commonly used by the ethnic healers, and that these are new medicinal resources to be developed for health care of modern society; (4) comparative ethnoherbology is, and will be, an attractive subject which will benefit both the discovery of new drugs and the study of the relationship among tribes; (5) China ethnoherbology has been, and will be, successful in developing more powerful remedies.

**Ashok Kumar SRIVASTAVA,** Department of Botany, MG. Degree College, Gorakhpur 273001, India

**THREATENED MEDICINAL PLANTS OF TARAI FOREST OF GORAKHPUR**

Increasing demands for indigenous herbal drugs and their exploitation by aboriginal tribes, traders, researchers, and recently by pharmaceutical companies threaten our wealth of valuable medicinal plants. Urbanization and unplanned growth of residential areas also affect plant distributions. This paper highlights some important plants of the Gorakhpur forest which need urgent conservation before they become extinct. The important plants of this area are *Aristolochia indica* L., *Asparagus racemosus* Wild, *Dioscorea bulbifera* L., *Flacourtia jangomas* (Lour.) Reeusch., *Gloriosa superba* L., *Helminthostachys zeylanica* L., *Ophioglossum reticulatum* L., *Rauvolfia serpentina* Benth. & Kurz. and *R. tetraphylla* L. These are described along with parts used, habitats, localities, and causes of threat.

**Victor TOLEDO,** Centro de Ecologiá, Universidad Nacional Autónoma de México, Apartado Postal 70–275, México, DF–04510, México

**GREEN ECONOMICS AND INDIGENOUS WISDOM: HOW MANY PRODUCTS ARE ENCLOSED IN A TROPICAL FOREST?**

The whole spectrum of forest products recognized by eight indigenous groups of tropical Mexico is presented and analyzed. More than 2,500 ''ethnoproducts'' corresponding to over 1,500 plant species were identified from the tropical rain

forests of Mexico. For each species information is given about scientific and common name, botanical family, location, type of use, part used, lifeform, habitat, and indigenous groups from which the data were obtained. The number and quality of these products are also reviewed on four different scales (sites, localities, microregions, and the entire nation). The results of this research are then compared with those obtained by other authors in different tropical forests of Africa and Latin America. The paper ends by discussing the importance and limitations of this tropical indigenous wisdom for the development of a new green economy.

**Mollie S. TOLL,** Office of Archaeological Studies, Museum of New Mexico, P.O. Box 2087, Santa Fe, NM 87504–2087.

**BOTANICAL ANALYSIS OF THE WAREROOM AT HUBBELL TRADING POST: CHRONICLING SOME ECONOMIC PATTERNS OF NAVAJOS, HOPIS, AND ANGLOS IN THE LAST 100 YEARS**

Hubbell, a working trading post in northeastern Arizona now owned by the National Park Service, recently underwent some structural renovations. The debris that filtered through the floor boards in a large wareroom reflects both local crop production and botanical imports. Archival photos and inventories provide specific counterpoint to the materials recovered, fleshing out the list of materials passing through the wareroom, and pointing out selective patterns in degradation, disturbance, and archaeological collection. The growing body of archaeobotanical data sets from other trading posts in the Four Corners area, and from historic sites on the Hopi, Navajo, and Zuni reservations, allows views into the interplay of indigenous and introduced domesticated crops.

**Michael TOPLYN,** Harvard University (15 Highland Ave., Somerville, MA 02143)

**LIVESTOCK, LIMITANEI, AND STRATEGIES OF MILITARY SUBSISTENCE ON ROME'S ARABIAN FRONTIER (A.D. 284–551)**

Although the past 30 years have seen an upsurge of archaeological interest in the lifestyle, deployment, and maintenance of Roman soldiery, there has been little emphasis on understanding the subsistence economy of the frontier legions, a research problem which can be addressed directly through the study of food refuse. To date, most zooarchaeological insights bearing on the logistics of food provisioning for the Roman army have been based on studies of skeletal material from excavated sites in Europe. Comparable evidence for the dietary maintenance of Rome's military establishment in Arabia is practically nonexistent.

This paper represents the first attempt to fill that vacuum by merging the results of archaeofaunal analysis with ancient literary sources. Specifically, the large sample of animal bones (ca. 85,000 fragments) recovered from military sites of the *Limes Arabicus* Project in central Jordan (el-Lejjun, Rujm Beni Yasser, Qasr Bshir, De'janiya) is used to investigate the economic status of the *limitanei,* or frontier troops of Roman Arabia. My research involves intersite comparisons of mortality profiles, carcass part distributions, and osteometric results. At issue

is the long-lived controversy centered on the functions of the *limitanei,* who once were thought to have evolved, by the fourth century, into a peasant militia of part-time soldiers which farmed government lands and performed the duties of frontier guards. Current historical opinion, relying solely on literary evidence, favors the view that frontier garrisons were largely reliant on the imperial bureaucracy for imported food. The methodology I have adopted to address this problem involved the identification of livestock culling practices through the application of skeletal ageing techniques (epiphyseal fusion, tooth eruption/wear). Mortality profiles for sheep and goats are contrasted with ethnographically derived models of caprine production which differentiate between animal exploitation for local subsistence and herd management for production goals geared to exchange.

The archaeofaunal evidence of the *Limes Arabicus* Project clearly indicates that the pastoral economies of frontier garrisons were characterized by subsistence autonomy in the late third through mid-sixth centuries. Bones of domestic caprines consistently reflect patterns of exploitation typical of the agro-pastoral economies of peasant farming communities. Temporal distributions of caprine carcass parts support mortality data in suggesting that military sites neither obtained meat from outlying settlements, nor routinely supplied it to military or civilian sites. However, the bones of pack animals (donkeys, mules, camels) imply the regular importation of supplies to frontier outposts, supplies which included foodstuffs such as parrotfishes (Scaridae) which could not be acquired locally. Moreover, the use of camel hybrids in overland transport is suggested by results of osteometric analysis. Although the zooarchaeological evidence of the *Limes Arabicus* Project does not conclusively prove that all *limitanei* stationed on the eastern frontier were peasant farmers, it does demonstrate a far greater degree of subsistence autonomy for frontier garrisons than generally has been supposed. This result has profound implications for an expanded understanding of Roman frontier policy and military recruitment practices in the time of the Late Empire.

**Julian TREVINO-VILLARREAL, L. CORRAL-PEREZ, A.M. DELGADO-GUILLEN, R.I. JIMINEZ-SILVA, J.A. MALDONADO-HERNANDEZ,** and **J.A. BALDERRAMA-ALARCON,** Instituto de Ecología y Alimentos, Universidad Autónoma de Tamaulipas, Blvd. Adolfo Lopez Mateos 928, CD Victoria, Tamaulipas, 87040

**ETHNOZOOLOGICAL STUDY OF MAMMALS FROM ''EL CIELO'' BIOSPHERE RESERVE, TAMAULIPAS, MEXICO**

This study presents information about the utilization of mammals at ''El Cielo'' Biosphere Reserve, Tamaulipas, Mexico. The objective of this research was the elaboration of checklists that would increase our knowledge of the kinds of mammals utilized by local people and how these mammals were used by them. Three hundred and twenty one interviews were carried out in 13 different local communities during 15 field trips. A photographic album of mammals found in the areas was made in order to help the local people identify the species. Results

of all the interviews (159) were recorded with a computer program called "Fox Base." Our results showed that only 49.5% of the local people utilized mammals in some way. These interviews also showed that local people utilized 24 different species of mammals. The species most utilized were the nine-banded Armadillo *(Dasypus novemcinctus)* and the eastern cottontail *(Sylvilagus floridanus),* at 10.1% each. The least utilized were the southern flying squirrel *(Glaucomys volans)* and the *tayra (Eira barbara),* at 0.6% each. Four main methods of utilization were identified in this study: fur trade, food, medicine, and as pets. Finally, this study discusses the different ways mammals are utilized by the local communities.

**Chusie TRISONTHI,** Department of Biology, Faculty of Science, ChiangMai University, ChiangMai, 50002, Thailand

**EDIBLE WILD FRUITS IN NORTHERN THAILAND**

Thailand stretches from the wet tropics north into the dry subtropical region, where plant species diversity is high. The wild plants in northern Thailand are of tremendous importance to the rural economy. Edible fruit is one of the important forest products. These fruits are collected from the forest and sold in the markets. Some of these fruit plants are becoming endangered because ecological problems, such as drought, affect their growth.

A survey of wild plants producing edible fruits was carried out with the purpose of increasing public awareness of their conservation. Over 50 species of wild plants producing edible fruits from eight provinces of northern Thailand were collected and identified. These fruit plants belong to 40 genera and 25 families. The dominant species, such as *Canarium subulatum, Castanopsis diversifolia, Irvingia Malayana, Protium serratum, Schleichera oleosa,* and *Spondias pinnata* are distributed in all provinces. Details on each species, such as local names, scientific name, location, and method of preparation for food are fully described in the presentation.

**Nancy J. TURNER** and **Alison DAVIS,** Environmental Studies Program, Box 3045, University of Victoria, Victoria, B.C., V8X 3P4, Canada

**"WHEN EVERYTHING WAS SCARCE:" THE ROLE OF PLANTS AS FAMINE FOODS IN NORTHWESTERN NORTH AMERICA**

Interviews with indigenous elders and literature reports indicate that plants have played an important role as survival foods for indigenous peoples of northwestern North America. Over 50 species of food plants are noted specifically to have been used to alleviate hunger and aid in survival in lean times. In prehistoric and early historic times, food shortages occurred periodically, usually in late winter and early spring when bad weather and other circumstances coincided with low quantities of stored foods and unexpected scarcity of fish and game. These famine foods were also resorted to by non-Aboriginal explorers, traders, and settlers. Most of the plant species identified as having been used in times of scarcity were routinely used as foods. They include, with regional variations,

some marine algae, the lichen *Bryoria fremontii,* tree species having edible inner bark (e.g., *Pinus contorta, Tsuga heretophylla),* species of ''root'' vegetables (e.g., *Camassia* spp., *Trifolium wormskioldii, Pteridium aquilinum, Lysichitum americanum, Dryopteris expansa, Claytonia lanceolata, Cirsium undulatum),* green stem and leaf vegetables (e.g., *Opuntia* spp., *Heracleum lanatum),* and long-lasting fruits such as *Arctostaphylos uva-ursi, Viburnum edule,* and *Rosa* spp. As well as famine foods, some plants *(Polypodium glycyrrhiza* rhizomes, *Gaultheria shallon* leaves, *Blechnum spicant* fronds) were used as temporary hunger suppressants by hunters or travellers lacking more substantial foods. The dietary contributions of these plants are probably variable, but all should be regarded as highly significant because of their survival value.

**Gail E. WAGNER,** Department of Anthropology, University of South Carolina, Columbia, SC 29208

**NATIVE AMERICAN GARDENS IN EASTERN NORTH AMERICA**

There is little direct archaeological evidence on Native American gardens and landscaping in eastern North America, although we have a growing data base on what plants were used or grown. Spanish, French, and English accounts and drawings from the sixteenth through the eighteenth centuries provide scattered descriptions of fields, gardens, and other maintained landscapes. In this summary I examine not only what crops were grown or encouraged, but also where they were placed and who managed them.

**David E. WILLIAMS,** National Germplasm Resources Laboratory, USDA-ARS, Building 003, 4th Floor, BARC-West, Beltsville, MD 20705

**IMPACT OF NATIVE FARMERS ON PEANUT DIVERSITY: PAST, PRESENT, AND FUTURE**

The important role of indigenous farmers in the generation and maintenance of peanut diversity has not been fully appreciated. Very little direct evidence remains, other than the peanuts themselves, to indicate the exact means by which such great diversity evolved in prehistoric times, but there is a clear correlation between peanut geno-centers and the aboriginal culture areas. Presently, native farmers throughout the warmer parts of the Americas continue to maintain a great deal of peanut genetic diversity as part of their ancestral farming systems. A recent study of some of these native farming practices has shown them to be instrumental in generating and maintaining peanut diversity. As the need for a global strategy to preserve crop genetic resources becomes more urgent, native farmers need to be included in this effort so that the ongoing evolution and maintenance of the cultigen in situ are not interrupted.

**Elizabeth S. WING,** Florida Museum of Natural History, University of Florida, Museum Road, Gainesville, FL 32611, and **Stephen R. WING,** University of California–Davis

**COLONIZATION OF ISLANDS**

In their colonization of islands, pre-industrial people faced limitations described by island biogeographical models. Two ways in which these limitations were mitigated were by the introduction of domestic and captive mainland animals and by intensive exploitation of marine resources. Many examples of prehistoric introductions of animals to islands by people have been documented from different times and places; the Caribbean is one such case. Faunal assemblages excavated from sites on islands in the Caribbean demonstrate the exploitation of a number of different marine habitats. We used measures of species diversity and equitability to examine the degree to which human technology can compensate for the limited diversity of terrestrial fauna on islands that are small and distant from the mainland.

**L. Anthony ZALUCHA,** Paleoethnobotanical Consulting, 109 Sunset Lane, Mount Horeb, WI 53572

**WOOD CHARCOAL FROM THE VALLEY VIEW SITE**

The Valley View site (47LC34), located near La Crosse, Wisconsin, is an Orr Phase Oneota village occuped about A.D. 1500. The intensively excavated northern portion of the site revealed a complex of pit features. Intensive matrix sampling from the features resulted in a large data base of charcoal from discrete depositional episodes. Five morphological feature types were defined. Different patterns of species presence were noted across the feature types. Statistical analysis suggests that these differences are due to cultural causes, not to chance factors of pit size or number of depositional episodes. Identified species are consistent with vegetational conditions like those present at the time of European arrival. Xeric forests and conifer swamps were the preferred wood resource zones. Woods from the latter zone must have been highly prized since vegetational reconstruction shows that the nearest swamps were several miles distant. Analysis of a burned structure shows that oak, birch, and tamarack were used for construction.

# BOOK REVIEW

**The Abandoned Narcotic: Kava and Cultural Instability in Melanesia.** Ron Brunton. Cambridge Studies in Social Athropology, 9. Cambridge, U.K.: Cambridge University Press, 1989. Pp. viii, 216. $39.50. ISBN 0-521-37375-1.

Prior to the entry of Europeans into the Pacific, relatively few plants were used by islanders as stimulants or drugs. One of these, *Piper methysticum,* was used in the preparation of kava, a drink that everywhere was prepared by chewing, grating, or pounding the roots of *P. methysticum* and mixing the results with water; no fermentation was involved. The plants' pharmacological properties clearly indicate its potential as a soporific, anticonvulsant, muscle relaxant, and local anesthetic—precisely the effects sought by kava drinkers, especially as they are seen to facilitate ritualized interaction with the supernatural world.

Brunton is concerned primarily with accounting for the geographical distribution of traditional kava drinking, which is indeed curious. At the time of European contact, kava was a ritually important drink throughout Polynesia, but only on two islands in Micronesia and in a few, widely separated parts of Melanesia. W. H. R. Rivers, one of the major proponents of diffusionist approaches to Oceanic culture history, argued in 1914 that such a distribution reflected the historical movements of two waves of immigrants to Melanesia from Southeast Asia, ''kava people'' and, later, ''betel people,'' i.e., those who chewed betel nut (*Areca catechu*) with the leaves of *Piper betle* and slaked lime. Rivers proposed that kava, which was rarely plentiful and involved prolonged preparation, was abandoned by most Melanesians in favor of the simpler process of chewing betel, which allegedly induces comparable effects. Marshalling the available archaeological, botanical, ethnological, and linguistic evidence, Brunton explores Rivers's general notion that kava drinking was formerly more widespread in Melanesia and subsequently abandoned in most locations, as well as a competing hypothesis of multiple independent inventions.

The diverse and complementary evidence Brunton assembles is persuasive, and it would indeed seem that ''there can be little doubt that kava drinking had a single point of origin'' (p. 75). It also appears that precontact direct links between the kava-drinking areas of Melanesia are ''totally implausible'' (p. 78), leading to Brunton's conclusion that the distribution of kava drinking in Melanasia at the time of European contact is to be explained by postulating that ''there were people in intermediary areas . . . who once drank kava as well, but they abandoned it some time before European contact'' (p. 80). The intriguing remaining issue, then, has to do with why this abandonment took place.

Brunton rejects Rivers's argument that kava drinking was abandoned in favor of betel chewing and I think he is correct to do so, if for no other reason than that the two drugs are not necessarily competitors, and indeed they do not have mutually exclusive distributions. For any given location, *Piper methysticum's* requirements of high rainfall, well-drained soil, and shelter from sun and wind, combined with its apparent dependence on vegetative propagation made it

likely that a climatic catastrophe could make abandoment an irreversible process (pp. 90–92), and perhaps no reasons other than ecological ones need be sought. But Brunton is a social anthropologist, and for him ''the most important, as well as the most anthropologically interesting, explanation'' for kava's abandonment is related to ''the high degree of religious instability in Melanesia'' (pp. 92, 93).

Brunton devotes almost half of his book (pp. 95–167) to a case study, that of the island of Tanna in Vanuatu, to exemplify processes that he believes were and continue to be widespread in Melanesia. He supplements his Tannese material with citations of the ethnographic literature to make to general points: (1) that ''the major significance of kava in virtually all the societies in which it was drunk was ritual or religious'' (p. 170); and (2) that Melanesia, and particularly New Guinea, is rife with examples of major ritual complexes or practices being modified or abandoned in precontact times or following European contact and, according to Brunton, for reasons similar to those behind kava's varying fate in Tanna, that the drug (or cult, or ritual) was perceived to be either ''too strong'' to be safe, or the opposite, that is was no longer efficacious in the light of social changes.

Why, then, was kava drinking retained in some parts of Melanesia, either as a secular or ritual practice, rather than abandoned? Brunton proposes that ''variation will depend on the strength of institutions of social co-ordination and authority, the degree of trust within local communities, and the extent to which the requisite ritual knowledge is dispersed'' (p. 176). Melanesian specialists will recognize these as social factors that are indeed highly variable (and much more so than in Polynesia, where kava drinking has, apparently, been as stable as the social orders there), but a systematic mapping of this variation against the distribution of kava drinking is the obvious next step needed.

Brunton stops short of such a project, but his innovative work will doubtless stimulate others to attempt it. And that will surely be a breath of fresh air in today's ''postmodern'' anthropology, which seems to have little interest in ''distribution studies.'' *The Abandoned Narcotic* is especially welcome in drawing our attention to the importance of attending to nonfood plants as we continue to explore the boundless relevance of ethnobiology to our broader understanding of human beings.

Terence E. Hays
Rhode Island College
Providence, RI 02908

# NEWS AND COMMENTS

## PROJECTS AND PROGRAMS

**The Central American Institute of Prehistoric and Traditional Cultures at Belize**

This institute was established under a charter from the government of Belize as a scientific, educational, and nonprofit organization for the purposes of promoting the preservation of ancient and traditional cultural ethos and materials, and to act as a center for the dissemination of knowledge and interest in the study of such cultures. These activities include scientific research and archaeological investigations, preservation for public benefit of archaeological monuments and historical landmarks, as well as academic and educational programs on all aspects relating to prehistory, ethnohistory, and the ethnographic present.

A total of 27 acres of jungle terrain, kept as a natural preserve, have been dedicated for an ethnobotanical field station, which is to serve as a research facility where plants of ethnomedical interest and ritual importance can be studied in their native habitat. The Institute also encourages work in wildlife and tropical resource management, to be pursued from indigenous and traditional points of view. The Institute's address in Belize is 20 Macaw Avenue, Belmopan, Belize, Central America.

For more information contact Dr. Michael Ripinsky-Naxon, Director, Central American Institute, 68-769 First Street, Suite 286, Cathedral City, CA 92234-1244, USA; fax number 1/619/324-8862. [Extracted from a press release and other materials submitted by Agata Dukat, administrator of the Institute].

## JOURNALS AND OTHER MEDIA

*Etnoecologica,* a new journal edited by Victor Toledo of the Center of Ecology, National Autonomous University of Mexico, is dedicated to the study of the traditional management and conservation of nature. In the first number—dated April, 1992—there are five sections: *editorial,* which contains scientific articles as well as general commentaries; *breves*, which are short communications; *debate*, including long opinion pieces; *voces* carries short reflections, often from indigenous people; and *libros* closes the journal with book reviews.

Articles are accepted in English, Spanish, or French. An annual subscription, which includes two numbers, is available from: Victor M. Toledo, Apdo. Postal 41-H, Sta. Ma. Guido, Morelia, Michoacan 58090, México; fax number 51/5/548-5259.

## COMMENTS, OPINIONS, AND RESPONSES

At present, the *Journal of Ethnobiology* accepts scientific articles, short communications, book reviews and, for this column, newsworthy items, and comments on papers published in the *Journal*. In a slight departure from this policy,

Willard Van Asdall, the former editor of the *Journal*, accepted an article by Darrell Posey entitled "Intellectual property rights: what is the position of ethnobiology," which was published in the Summer, 1990 issue. This opinion piece, which was not submitted to reviewers, addressed some of the political and economic implications of our research.

Following up on this precedent, I would like to open an editorial space in the News and Comments column. Readers are invited to submit short opinion pieces, of 500 words or less, which address the applied aspects of ethnobiological research or other issues of concern to ethnobiologists. [By the editor of News and Comments].

## REQUESTS FOR INFORMATION

An issue on the minds of some participants at the Fifteenth Annual Ethnobiology Conference in Washington, D.C., was the lack of information on university-level degree programs and courses on ethnobiology. Ethnobiologists often receive requests from students about where to seek advanced training in our field, and are unable to give a suitable answer. Eugene Hunn has suggested that a directory be published, perhaps in the *Journal*, of professors and academic institutions that offer training in ethnobiological theory and methods. If you know of programs, whether in the United States or in a foreign country, please contact the editor of the News and Comments section. After reviewing the initial responses, I may conduct a more formal survey and publish the results in the *Journal*. [By the editor of News and Comments].

# BOOK REVIEW

**Early Animal Domestication and its Cultural Context.** Pam J. Crabtree, Douglas Campana, and Kathleen Ryan, editors. Philadelphia: MASCA Research Papers in Science and Archaeology, Special Supplement to Volume 6; The Museum of Applied Science Center for Archaeology, The University Museum of Archaeology and Anthropology, University of Pennsylvania, 1989. Pp. vii, 136. 54 figures; 19 tables; no index. $32.00 U.S. (hardcover). ISSN 1048-5325.

This slim, well-edited volume is a collection of separate papers put together as a tribute to Dexter Perkins. Perkins (1927–1983) and his wife Patricia Daly were in the forefront of research on the origins and development of animal domestication in the Near East during the 1960s and 1970s.

A short biography of Perkins by R. Solecki and review of Perkins's scholarly contributions by Crabtree and Campana introduce the book. The remaining seven papers are accounts of original zooarchaeological research, several of which deal with samples originally described by Perkins, and others relevant to the Near East or the topic of animal domestication. Three papers focus on analytical problems: the distribution of wild sheep in the Indus valley (R. Meadow); a reappraisal of a histological screening technique proposed by Perkins and his colleagues for the determination of domesticated status in animal bone (A. Gilbert); and an overview of the archaeology of horse riding (D. Anthony and D. Brown). The Gilbert paper, the longest in the book, reveals some of the development of zooarchaeology as a science. Patterns in bone thin sections had been interpreted as signs of domesticated status, but now appear to be diagenetic artifacts, a familiar disappointment to many who work on degraded archaeological samples. Patterns in the architecture of spongy bone may indeed indicate some difference in wild and domestic activity patterns, as Drew, Perkins, and Daly had suggested, but establishing a modern baseline for such changes has been prohibitively time consuming and expensive. This also is a familiar story to those working on the biological effects of human control of living animals.

The remaining papers focus of assemblages of animal bones in a regional context. The authors cover early animal domestication in India (P. Rissman); the middle and upper Paleolithic of the Zagros (B. Hesse); hunting in early village economies in Anatolia (G. Stein); and the colonization of northern Europe (P. Bogucki). Taken together, these papers show how vast an amount of site-specific data must be collected before interesting cultural patterns emerge. The collective weakness of these papers is the lack of coordination between analyses of animal remains and analyses of forage and crops, partly, but not wholly, because the latter data do not exist.

One of Perkins's accomplishments was his insistence on the place of zooarchaeology within the field of archaeology, rather than zoology as had previously been the tradition in the United States. Here, the authors deal with chronologies,

cultural context, and artifact assemblages as they interpret patterns in animal bone assemblages. At the same time, they are expert (or collaborate with experts) in many physical sciences in addition to mammalian morphology and bone biology. The fruits of this approach are a reconstruction of animal use in the Near East which is deliberately focused upon human use of, and alteration of, the natural environment. This readable book is not comprehensive enough in coverage to be used as a basic reference for this region, but it is a showcase for research methodology and regional synthesis on an important problem and area.

Katherine M. Moore
Department of Behavioral Science
Bentley College
Waltham, MA 02154

## BOOK REVIEW

**The Tlingit Indians.** George Emmons, edited with additions by Frederica de Laguna. Biography by Jean Low. Seattle and London: University of Washington Press, 1992. Pp. 530. 65 line drawings, 127 photographs. $60.00 (hardcover). ISBN 0–295–97008–1.

*The Tlingit Indians* is sumptuously produced, encyclopedic, and well illustrated. It represents a monumental effort of some 60 years' labor between Emmons and de Laguna. De Laguna has performed an invaluable service in making Emmons's extensive Tlingit data, and his interpretations of them, available for the first time. *The Tlingit Indians* is based on Emmons's decades of fieldwork in southeast Alaska and intimate knowledge of the Tlingit. As its publication is more than a century after the beginning of his fieldwork, the work has an archival quality and represents a valuable time depth in the understanding of the Tlingit. This quality is enhanced by the copious quotations from early sources regarding Tlingit life in the eighteenth and early nineteenth centuries, including Russian sources, and other observations of the Tlingit in the late nineteenth century. Numerous reproductions of early renderings of the Tlingit are used as illustrations, along with many sketches by Emmons himself, showing traditional dress, housing, transportation, and technology. Archival photos also illustrate such topics as shamanistic curing, ceremonial costume, and traditional houses, canoes, and totem poles. The volume is an excellent addition to available material on the Tlingit and Northwest Coast cultures.

*The Tlingit Indians* is a comprehensive ethnography. Chapters cover the land and people, social organization, villages, houses, forts, and other works, travel and transportation, fishing and hunting, food and its preparation, men's and women's arts and industries, dress and decoration, the life cycle, ceremonies, war and peace, illness and medicine, shamanism, witchcraft, games and gambl-

ing, and time, tides, and winds. The 37 tables cover many aspects of Tlingit life and land, including climatic and vegetation data, population, social structure, uses of animals and plants, ceremonies, and medical practice. A bibliography (updated to include important modern references) and an index are also included.

De Laguna's decision to intersperse Emmons's original material, in bold text, with selections, comments, and quotations written by her in lighter type and enclosed in brackets, leads to some distraction in reading. The material she has amassed adds immensely to the value of the work, however. The segregation of the tables at the back of the volume is a minor inconvenience.

Valuable for the ethnobiologist are tables of edible marine resources (invertebrates and algae), edible plants, colors, paints, dyes and stains, basketry materials, and medicines. De Laguna has enlisted the services of the ethnobotanist Alix Wennekens to supply scientific names for the plants discussed by Emmons, which is very helpful. The addition of scientific names in the text for plant foods and medicines, as well as in the tables, would enhance the ease of use of the book for ethnobiologists. The discussions of harvesting and processing food plants and basketry materials are extremely useful. Good treatments of traditional hunting and fishing techniques are also included. A minor error in the food plant section is the identification of the edible fern root as lady fern *(Athyrium filix-femina)*. Turner et al. (1992) have demonstrated that the fern rootstock collected by the Tlingit is *Dryopteris expansa*.

*The Tlingit Indians* is a good value for anyone interested in the cultures of the Northwest Coast of North America, or in hunter-gatherer subsistence and technology. The book is also valuable for those with an interest in traditional medicines, as it has extensive sections on diagnosis and treatment of illness, shamanism, and witchcraft.

## LITERATURE CITED

TURNER, NANCY J., LESLIE M. JOHNSON GOTTESFELD, HARRIET V. KUHNLEIN, and ADOLF CESKA. 1992. Edible wood fern rootstocks of western North America: Solving an ethnobotanical puzzle. Journal of Ethnobiology 12:1–34.

Leslie M. Johnson Gottesfeld
Department of Anthropology
University of Alberta
Edmonton, Alberta, Canada

# BOOK REVIEW

**The Seven Sisters of Sleep.** Mordecai C. Cooke. Lincoln, MA: Quarterman Publications, Inc. (P.O. Box 156, Lincoln, MA 01773), 1989 (reproduction of original 1860 edition). Pp. xi, 371. $45.00 (clothbound). ISBN 0–88000–146–1.

Mordecai Cubitt Cooke's first book, *The Seven Sisters of Sleep,* originally published in 1860, is one of the rarest classics of the psychoactive drug literature, with only a few copies known to exist in U.S. libraries (Cooke 1860). The third book to survey the topic and the second in English, published just five years after *The Chemistry of Common Life* (Johnston 1855) and *Die Narkotischen Genussmittel und der Mensch* (Bibra 1855), *The Seven Sisters of Sleep* is now available in a facsimile edition of 1000 copies. The book is well bound, and features a foreword by Richard Evans Schultes and Michael R. Aldrich, which places it in historical context. The book lacks a bibliography or index. There is a frontispiece photograph of the author as an elderly man, and six line drawings in the text of traditional tobacco and *betel* paraphernalia. Quarterman is to be commended for publishing this rare book, which will be followed by an English translation of von Bibra's 1855 classic.

The "seven sisters" of the title are the seven "narcotic" or psychoactive plants discussed in the book—tobacco (*Nicotiana* spp.), opium (*Papaver somniferum* L.), hemp or marijuana (*Cannabis* spp.), *betel* (*Arecha catechu* L.), *coca* (*Erythroxylum* spp.), thornapple (*Datura* spp.) and "the exile of Siberia," the fly–agaric (*Amanita muscaria* L. ex Fr.) (Pers. ex Gray). In his opening chapter, Cooke introduces his seven drugs with a charming legend of the "Seven Sisters of Sleep" he invented for the occasion, and in the following chapter he surveys some references to inebriants in the ancient world. There follow six chapters, making up about a fourth of the book, on that "wond'rous weed" tobacco. After covering the history and ethnobotany of tobacco, Cooke discourses on "pipeology," the history of tobacco pipes, then devotes individual chapters to tobacco snuffing (in which he mentions *niopo,* entheogenic *Anadenanthera* snuff from the Orinoco) and tobacco chewing. A brief chapter on tobacco substitutes leads into six chapters on opium, covering natural history, ethnopharmacology, and effects, both positive ("Revels and Reveries") and negative ("Pandemonium"). There is a Victorian chapter on "Opium Morals" and a chapter on opium substitutes. Three chapters on hemp deal with its history, effects, and ethnopharmacology, followed by three chapters of similar information regarding *betel*. *Coca* ("Our Lady of Yongas"), "*Datura* and Co." and *Amanita muscaria* are each covered in a single chapter, and there are two chapters on inorganic drugs, the first on the alimentary and medicinal use of "Whitewash and Clay," the second on medicinal use of "Precious Metals," in this case the not–so–precious arsenic and mercury. A final chapter, in which the author goes about "gathering the crumbs," concludes with an *apologia* for the tobacco habit, and the fabled angel of sleep tenderly embraces the angel of death as the curtain closes; to an encore Appendix of 19 tables.

This quaint and witty book is well written and provides an entertaining introduction to the subject for the nonspecialist. Cooke's florid and whimsical style will delight the lover of Victorian literature. The book presents solid, though dated information on the "seven sisters," and mentions many other, lesser-known inebriating plants. Although this wonderful book has been a lost classic for the past century, it has had a lasting impact on our culture. *The Seven Sisters of Sleep* is widely regarded to have inspired Lewis Carroll in the writing of *Alice's Adventures in Wonderland*—especially the scene of the hookah-smoking caterpillar sitting on a mushroom which could make Alice grow larger or smaller, just as Cooke's "Exile of Siberia" was said to give "erroneous impressions of size and distance"—

> a straw lying in the road becomes a formidable object, to overcome which, a leap is taken sufficient to clear a barrel of ale ...

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Jonathan Ott
Natural Products Co.
Apartado Postal 274
Xalapa, Veracruz, México

# BOOK REVIEW

**Medicinal Wild Plants of the Prairie: An Ethnobotanical Guide.** Kelly Kindscher. Lawrence: University Press of Kansas (2501 W. 15th, Lawrence, KS 66049-3904), 1992. Pp. xi, 340. 105 maps, 43 line drawings by William S. Whitney. $25.00 (clothbound) ISBN 0-7006-0526-6. $9.95 (paperbound) ISBN 0-7006-0527-4.

Kelly Kindscher's new book, a companion to his 1987 book on wild edible plants of the North American plains (Kindscher 1987), presents 43 monographs on important medicinal species. Each monograph averages five pages and features a full-page line drawing of the plant, a small distribution map, and the following sections: Common Names, Indian Names, Scientific Names (including explanation of the name and common synonyms), Description, Habitat, Parts Used, Indian Use, Anglo Folk Use, Medical History, Scientific Research, and Culti-

vation. In general, the descriptions (of a single paragraph) together with the illustrations are adequate for identification purposes. Accounts of Indian and Anglo folk use are fairly comprehensive, as are the notes on medical history. Information on cultivation is rather sketchy in most cases, but is at times based on the author's personal experience in Kansas. A six-page glossary will aid the amateur with botanical and (at times quaint) medical terminology, and all sections make reference to a bibliography (replete with full journal and article titles, plus page numbers) of 259 sources, which covers the major publications on North American medical ethnobotany. The book ends with a useful index of 26 pages.

After the first section of monographs of the most important "Medicinal Wild Plants of the Prairie," there follows a section of "Other Medicinal Prairie Plants," 60 in all. This sections consists of mini-monographs which average about a page each, and include a distribution map, but no plant illustration. In every case the scientific and popular name of the plant is given, followed by the name of its family and its popular name. A brief description is followed by a paragraph or two detailing ethnobotanical use. Data on medical history, phytochemistry, and/or cultivation round out each mini-monograph.

The book is handsomely designed and well printed on acid-free paper, although the paperback edition ought to be smythe-sewn as is the hardcover edition. A reference book like this will presumably be opened often, not just read once, and the few cents smythe-sewing adds to the cost of producing each book is more than justifiable. As it is, I would recommend the $25.00 hardcover over the $9.95 paperback for reasons of durability.

I recommend this book heartily to all ethnobiologists interested in ethnomedicine. Phytochemists will find the book useful, but by no means complete and up-to-date with regard to chemical information on these plants. Physicians and others attracted to herbal medicine will find much of interest here, but would do well to heed the frontispiece disclaimer which advises that "this book provides only limited information" on medicinal use and "contains descriptions, not prescriptions." Information on the use of some of these plants or their relatives as inebriants seems to have been ignored or glossed over. For example, Cree use of *Acorus calamus* L. as a stimulant and entheogen ("hallucinogen") is not mentioned (there is a reference to constituent *beta*-asarone as "a mild hallucinogen," although this benzene derivative is not found in North American strains used as inebriants). Traditional uses of *Artemisia ludoviciana* Nutt. suggestive of psychoactivity are not covered, nor is much attention paid to the psychoactive compound thujone found in *A. absinthium* L. and likely present in North American species of the genus. Likewise, the psychotropic aspect of *Lobelia inflata* L. is not emphasized. Similarly, the Hopi "hallucinogen" *Mirabilis multiflora* (Torr.) Gray is not mentioned in the section on *M. nyctaginea* (Michx.) MacM. References to the use of these plants as inebriants can be found in a recent survey of North American medicinal plants (Moerman 1986). Finally, the author neglects to mention the fact that *Desmanthus illinoensis* (Michx.) MacM. and *Lespedeza capitata* Michx. contain the entheogenic drug *N,N,*-dimethyltryptamine (DMT). Since DMT is

illegal, so, technically, are these plants (along with some 300 other species now known to contain scheduled drugs), which might influence the reader considering growing these species in a home garden. But these are minor points, and in no way detract from a useful and valuable book, which will be a significant additon to any ethnobiologist's library.

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Jonathan Ott
Natural Products Co.
Apartado Postal 274
Xalapa, Veracruz, México

# NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting recent issues of the *Journal.* If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

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Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Gary J. Martin, 94, Blvd. Flandrin, 75116, Paris, France. FAX: 33-1-44919882.

## BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from the readership of the *Journal.* Please send suggestions, comments, or reviews to one of the *Journal's* book review editors. Please see inside front cover for names and addresses.

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phone: (604) 721-6124
FAX: (604) 721-8653
E–MAIL: njturner@sol.UVic.CA

# EDITOR'S VIEW

With this issue of the *Journal* we initiate a new feature in the "News and Comments" section, "Opinions." As announced by News and Comments editor Gary Martin in the last issue, we open an editorial space for readers to submit short (less than 500 words) opinion pieces on issues of concern to ethnobiologists. Gary will select and edit this section; opinion pieces will not be sent for outside review. "News and Comments" is quite full this issue, and includes a stimulating exchange between Glenna Dean and Karl Reinhard on the use of pollen concentrations in coprolite analysis. Readers are encouraged to comment on articles published in the *Journal;* such comments are subject to peer review and response by the authors of the original articles.

I am pleased that three articles focused on wild *Cucurbita* gourds of eastern North America, generated from papers presented at the 1992 Society of Ethnobiology meetings in Washington, D.C., all appear in this issue. With apologies to those readers who may tire of the wild gourd, publishing these papers together presented a rare opportunity for the authors, and for the *Journal*, to showcase the application of multiple lines of evidence to an ethnobiological research problem.

I would like to acknowledge the hard work of Janis Alcorn and Cecil Brown, who are leaving the editorial board, and to welcome Gene Anderson to the board. The review process only works through the joint efforts of board members and reviewers; I thank everyone for their efforts and invite any reader who would like to be part of the reviewer pool to contact me.

Finally, special thanks to Linda Desmond, friend of the Society, former owner of I'm Your Type and Graphics. Before I became *Journal* editor, I never thought about typesetters, the skilled people who take marked up manuscripts, full of inserts, arrows, and words in exotic languages, and turn them into pages ready for printing. Linda typeset the *Journal* from practically its beginning until this issue. She made the editor's job easier; she made us look good. Thanks, Linda.

DMP

*J. Ethnobiol.* 13(1):1–15 Summer 1993

# MIDDEN AND COPROLITE DERIVED SUBSISTENCE EVIDENCE: AN ANALYSIS OF DATA FROM THE LA QUINTA SITE, SALTON BASIN, CALIFORNIA

MARK Q. SUTTON
*Department of Sociology and Anthropology*
*California State University, Bakersfield*
*9001 Stockdale Highway*
*Bakersfield, CA 93311–1099*

ABSTRACT.—An analysis of resource constituent remains recovered in coprolites from sites in the Salton Basin, California, reveals several patterns of food availability, preference, and utilization. Specific combinations of foods are noted, indicating possible "meals." The coprolite data, combined with traditional faunal and floral analyses, form a more comprehensive view of subsistence. It is recommended that noncoprolite data be integrated into coprolite studies.

RESUMEN.—Un análisis de los restos de los materiales constitutivos recuperados en coprolitos encontrados en algunos sitios de la cuenca del lago Salton, en California, muestran varios patrones de disponibilidad, preferencia, y utilización de alimentos. Se notan combinaciones específicas de alimentos, indicando posibles "comidas." Los datos derivados de los coprolitos, combinados con los análisis tradicionales de fauna y de flora, proporcionan una visión más completa de la subsistencia. Se recomienda que a los estudios sobre coprolitos se integren datos no derivados de los coprolitos mismos.

RÉSUMÉ.—Une analyse en resources constituantes des excréments humains, récupérés en coprolites des sites dans le Bassin "Salton" en Californie, révèle de différents modèles de la disponibilité des aliments préférés et utilisés. Des combinaisons spécifiques des aliments sont constatées indiquant des "repas" possibles. Les données sur le coprolite, combinées avec des analyses traditionnelles de la faune et de la flore, constituent une vue de subsistence plus complète. C'est à conseiller que les données noncoprolites soient intégrées dans lés études coprolites.

## INTRODUCTION

Coprolites, preserved human fecal matter, constitute a source of considerable information regarding prehistoric diet, nutrition, health, and pharmacology (see Fry 1985, Sobolik 1990, and Reinhard and Bryant 1992 for recent reviews of coprolite studies). Unfortunately, coprolites are very fragile and susceptible to decomposition, and so rarely are recovered archaeologically.

Coprolites form direct evidence of substances consumed, although not always as food, as opposed to standard faunal and floral remains, which form indirect dietary evidence. Archaeologists studying coprolites make a number of assumptions, often with great merit, regarding the nature and origin of the specimens.

First, it is assumed that materials present in coprolites were ingested by the person from whom the coprolite came and that such materials can be readily identified. Secondly, coprolites usually are viewed as largely representing the subsistence aspect of diet, with the identification of substances ingested for ceremonial and/or medicinal purposes being more difficult to interpret (Shafer et al. 1989). Third, it is assumed that each specimen represents a unique elimination event and is not mixed or combined with other such events. In spite of this, obvious fragments, possibly representing separate events, frequently are grouped together as one specimen for analysis. Further, it generally is assumed that materials present in a coprolite represent the food consumed within the 24-hour period preceding its deposition (e.g., Fry 1985:128), although this may not be the case (e.g., Sobolik 1988a:207; Jones 1986). As such, coprolites likely are a combination of several meals (e.g., Watson 1974:240).

Other factors are of note in coprolite analysis (see Sobolik 1988b:114). As the surviving (i.e., visible) materials are those that were not digested, only the indigestible part of the diet is visually represented and we do not understand all the taphonomic problems (i.e., digestion, processing, preservation, and so on) associated with coprolites. For example, large mammals will not be visually represented in coprolites, nor will animals that have been subjected to certain types of processing (e.g., filleting fish). However, this situation is changing with the addition of the immunological technique that can identify nonvisible constituents (Newman et al. 1993). Coprolites may be discovered singly or in concentrations that probably represent latrines. While the population responsible for a latrine coprolite deposit generally is assumed to be homogeneous, this may not be the case. If a particular segment of the population (e.g., with particular culinary customs) used a specific latrine, the sample would be skewed and the interpretations incorrect. Latrine reuse over time may be an additional concern. However, since these factors cannot currently be controlled, most researchers appear to assume sample homogeneity. Cumming's (1989) study of coprolites from Nubian mummies is a rare example of these factors being known.

Most researchers focus on the inter-specimen variation, a general analysis of constituents present in a sample of coprolites. Relative abundance is assumed to represent relative importance in the diet. However, little attention is given to patterns of resource combination and utilization (i.e., intra-specimen variation). The goal of the present study is to determine the patterns of food preferences and combinations within a sample of coprolites from the La Quinta site (CA-RIV-1179) in the Salton Basin, California and to integrate noncoprolite (i.e., midden-derived) faunal and floral data into an overall view of site-specific subsistence.

## THE SALTON BASIN DATA BASE

Coprolites have been recovered from six open sites in the northern Coachella Valley as part of excavation projects (Fig. 1). All sites lie within the ethnographic territory of the Cahuilla Indians (Bean 1978) who probably occupied the region at least since the final stand of Lake Cahuilla, some 500 years ago (Wilke 1978). The analysis of each of these coprolite series was conducted by first rehydrating the specimens in a solution of trisodium phosphate. Specimens then were filtered, dried, and passed through a series of small screens. Recognizable constituents

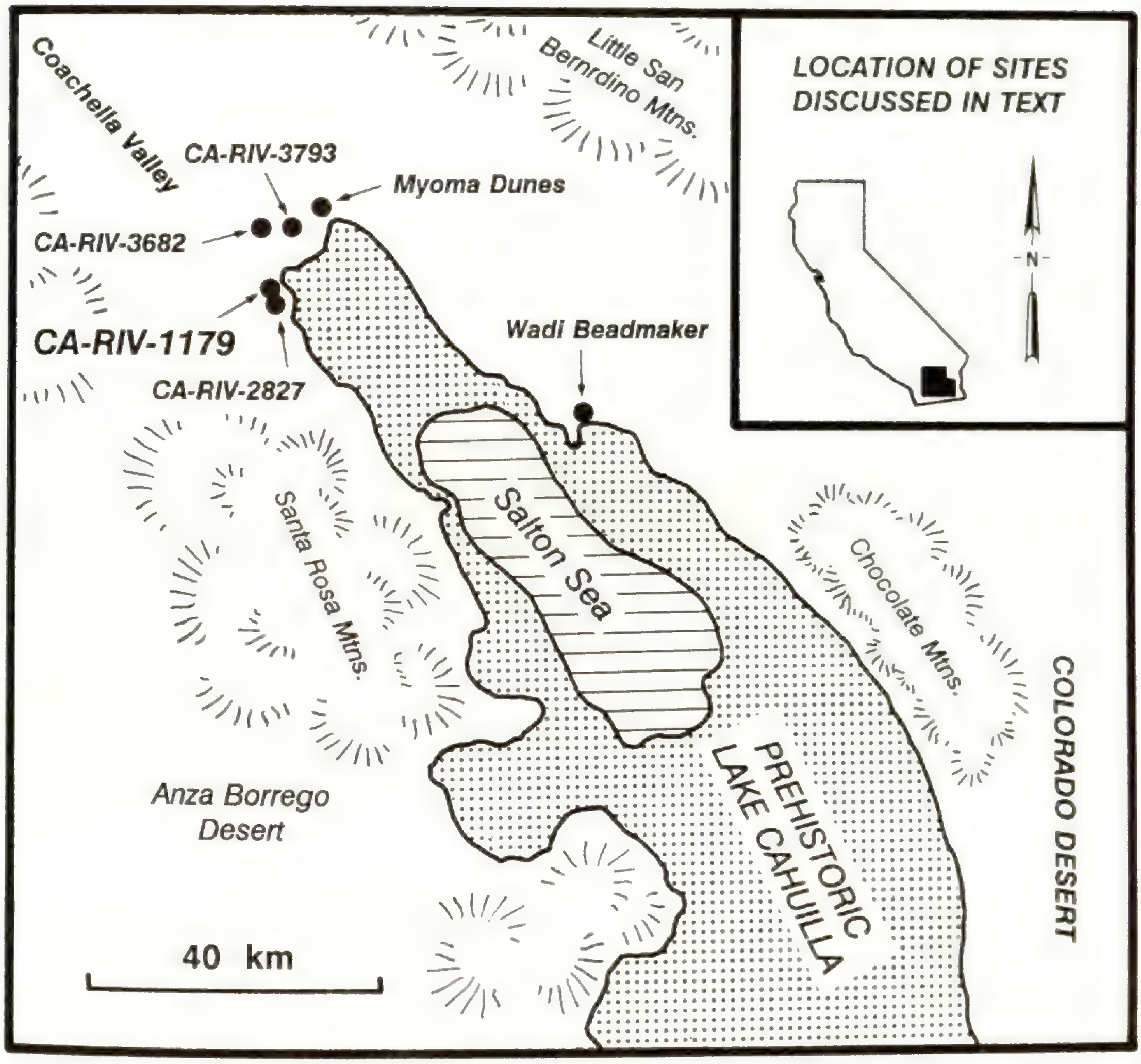


FIG. 1.—Location of prehistoric Lake Cahuilla and sites discussed in the text (adapted from Wilke 1978: Fig. 3).

were sorted and identified. Relative abundance was estimated following established techniques used in wildlife biology (see Wilke 1978:154–157 for a complete description of analytical techniques).

Three of the sites, CA-RIV-3682 (Yohe 1990), CA-RIV-3793 (Goodman and Arkush 1990; Goodman 1990), and CA-RIV-2827 (Sutton and Wilke 1988a; Farrell 1988) are small and contained limited assemblages of artifacts, ecofacts, and coprolites. The other three sites contained much larger numbers of coprolites plus other faunal and floral data.

The first of the larger sites, Myoma Dunes, is a series of habitation areas located in mesquite-anchored sand dunes along the northernmost shore of Lake Cahuilla and generally dates to the final stand of the lake, approximately A.D. 1500. Many artifacts, ecofacts, and about 1,000 coprolites were discovered. The site is located on the valley floor and is not directly adjacent to upland habitats. Analysis of materials recovered from the site was limited to a sample of the coprolites (Wilke 1978) and few complementary ecofactual data were reported.

The second large site, Wadi Beadmaker, is the remnant of an extensive camp located along the northeastern shore of the lake; it also dates to the final lake-stand. Excavation at the site resulted in recovery of numerous artifacts, ecofacts, and approximately 70 coprolites. As with Myoma Dunes, analysis of materials recovered from the site was limited to the coprolites (Wilke 1978) and no complementary ecofactual data were reported.

The third site, the La Quinta site (CA-RIV-1179), is located in an ecotone of at least three environmental zones (lake shore, desert, and mountain) along the northwestern shore of the former lake. The site was excavated in 1985. La Quinta consisted of a fairly large open camp dating from the final stand of Lake Cahuilla (ca. A.D. 1500) and contained numerous artifacts, ecofacts, cremations, and 128 coprolites. A full analytical report on the recovered materials was produced (Sutton and Wilke 1988a); this is the only such comprehensive report for a major site in the region.

Farrell (1988) analyzed 30 coprolites from the La Quinta site. Most were discovered in a relatively small area, suggesting the presence of a latrine. Macroscopic floral and faunal elements were identified to taxon where possible, the remainder being classified as unidentified fragments (Farrell 1988:132–133). Several specimens appeared to consist primarily of pollen, which was identified; however, no general pollen or phytolith studies were conducted on the samples. Abundance of materials recovered from the coprolites was ranked as abundant, frequent, infrequent, or trace based on the volume of material in each specimen.

Farrell (1988) noted fish bone in all analyzed coprolites. Two species, bonytail chub *(Gila elegans)* and razorback sucker *(Xyrauchen texanus),* were identified. Two other fish, the Colorado squawfish *(Ptychocheilus lucius)* and mullet *(Mugil cephalus),* also were present in prehistoric Lake Cahuilla. Mullet remains are abundant at some other lakeshore sites (Follett 1988:154) but were not identified at La Quinta. Squawfish remains were observed in the midden at the La Quinta site (Follett 1988:154).

Seven examples of articulated fish vertebrae were recovered from the La Quinta midden (Follett 1988); six bonytail chub and one razorback sucker. Five of the six chub examples consist of caudal vertebrae, indicating that tails had been removed and discarded (unconsumed?). The sixth chub specimen consisted of eight precaudal vertebrae. The razorback sucker specimen consisted of (apparently) precaudal vertebrae. This could possibly be the remains of a filleted fish.

## THE CURRENT STUDY

The objective of this study was to conduct a comparative analysis of the La Quinta coprolite constituents (from Farrell 1988) to determine whether any patterns of resource utilization were present. Such patterns might include food combinations that could be used to delineate dietary preference or habits (i.e., meals) and differences in the seasonal use of resources. Faunal and floral materials recovered from the general midden were then compared to the coprolite data in an attempt to discover additional patterns between the two data sets.

*Methods.*—The constituents identified in the La Quinta coprolites (Table 1) (Farrell 1988) were compared using a hierarchical cluster analysis, part of SPSS-PC (Statistical Package for the Social Sciences, Personal Computer). Membership to a

TABLE 1.—Coprolite clusters by constituent, CA-RIV-1179.

| Specimen[1] | Resource[2,3] | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
| **Cluster One** | | | | | | | | | | | | | | | | | | | |
| 6 (24–32) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 22 (16–48) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 12 (19–33) | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 7 (23–33) | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 10 (19–38) | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 (25–14) | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 1 |
| 29 (SC–4b) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 1 |
| 2 (25–22) | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 21 (16–49) | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 1 |
| 30 (SC–4a) | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 1 | 1 |
| 9 (23–30) | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 1 |
| 27 (16–32) | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 |
| 14 (17–51) | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 4 | 1 | 1 | 0 | 1 | 1 | 3 |
| **Cluster Two** | | | | | | | | | | | | | | | | | | | |
| 5 (24–35) | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| 20 (16–67) | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 4 (24–36) | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 1 (25–26) | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 |
| 17 (17–45) | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 18 (17–26) | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 4 |
| 28 (4–6) | 0 | 0 | 4 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 4 |
| **Cluster Three** | | | | | | | | | | | | | | | | | | | |
| 11 (19–35) | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 19 (16–68) | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 2 |
| 16 (17–46) | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 |
| 23 (16–43) | 4 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 2 |
| 15 (17–47) | 4 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 |
| 26 (16–34) | 4 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 3 |
| 13 (19–24) | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 2 |
| 25 (16–36) | 4 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 4 |
| **Cluster Four** | | | | | | | | | | | | | | | | | | | |
| 8 (23–32) | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 |
| 24 (16–39) | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 2 |

[1]Computer specimen numbers (1–30; see dendrogram); catalog numbers in parentheses

[2]Taxa list:

A bonytail *(Gila elegans)*
B razorback *(Xyrauchen texanus)*
C unident. fish
D tortoise *(Xerobates agassizii)*
E chuckwalla *(Sauromalus obesus)*
F unident. reptile
G cottontail *(Sylvilagus audubonii)*
H unident. mammal
I unident. vertebrate
J mussel shell *(Anodonta)*
K land snail *(Physa)*
L unident. insect
M cattail *(Typha)*
N bulrush *(Scirpus)*
O dicoria *(Dicoria canescens)*
P mesquite (*Prosopis* spp.)
Q goosefoot *(Chenopodium)*
R unident. seeds
S charcoal

[3]Abundance codes: 4 = abundant (A); 3 = frequent (F); 2 = infrequent (I); 1 = trace (T); 0 = not present

cluster was based on nearest neighbor to the center of the clusters, defined as average mean of the cluster. Numeric values (4 through 0) were assigned to the abundance rankings (abundant, frequent, infrequent, trace) given in the original study, with zero used to designate absence.

*Results.*— Four main clusters were defined in the analysis (Fig. 2). Each of these clusters exhibits a remarkably clear tendency of utilization of a particular resource.

Cluster One. Cluster One (n = 13) is dominated by cattail (*Typha* anthers and pollen; Farrell 1988:135); it being ranked very abundant (i.e., comprising over 50% of the mass of the specimen) in 12 of 13 samples and frequent in the other. Few fish, all identified as bonytail chub, are present; bulrush seeds (or tule; *Scirpus*) are present in trace amounts in six of the samples. No reptile remains, and only one fragment of an unidentified mammal, are present in these specimens. Charcoal occurs in only trace amounts in this cluster.

Cattail clearly was the major resource represented in this cluster. No cattail seeds were found, pollen apparently being the primary constituent in the samples (Farrell 1988:135). As it appears that at least some pollen may remain in the digestive tract up to a month after ingestion (Sobolik 1988a:208), large quantities likely represent meals while trace amounts may be residuals from earlier meals. After cattail, fish clearly is of secondary importance. Due to the low occurrence of charcoal in the samples, the fish may represent processed (e.g., dried) foods. Nonfish animal resources appear not to have been consumed in conjunction with cattail.

Farrell (1988:135) felt that the cattail was consumed raw. Cattail pollen is available fresh from May to July (Shreve and Wiggins 1964:229), suggesting that the Cluster One coprolites date from that season. Fish also should have been available in quantity during that time and their relative paucity may be the result of people concentrating on the collection of cattail.

Cluster Two. This cluster (n = 7) is dominated by unidentified fish which are mostly charred. No elements could be identified to genus. Present also are the only cottontail *(Sylvilagus)* and chuckwalla (*Sauromalus;* three scapulae in one specimen) remains identified during the study. Few plant resources were identified in this cluster and charcoal is abundant in only two specimens.

The specimens comprising Cluster Two may reflect a diet centered on the consumption of small terrestrial animal resources. This hypothesis is based on the absence of both identified fish and substantial floral remains and on the presence of (albeit few) terrestrial remains.

The presence of unidentified fish remains ranked as frequent in this cluster suggests that fish had been processed; perhaps fillets were made and dried (charred bone and infrequent charcoal being the result of the drying process) or fish (and bones) were ground on a metate. If this interpretation is correct it suggests the consumption of stored fish.

In light of the possibility discussed below, that bonytail were processed in two different ways, one resulting in the elimination of most bone, it is possible that the unidentified fish remains were bonytail and that fish was an important constituent in Cluster Two. Most visible remains (bones) were simply absent. Protein (immu-

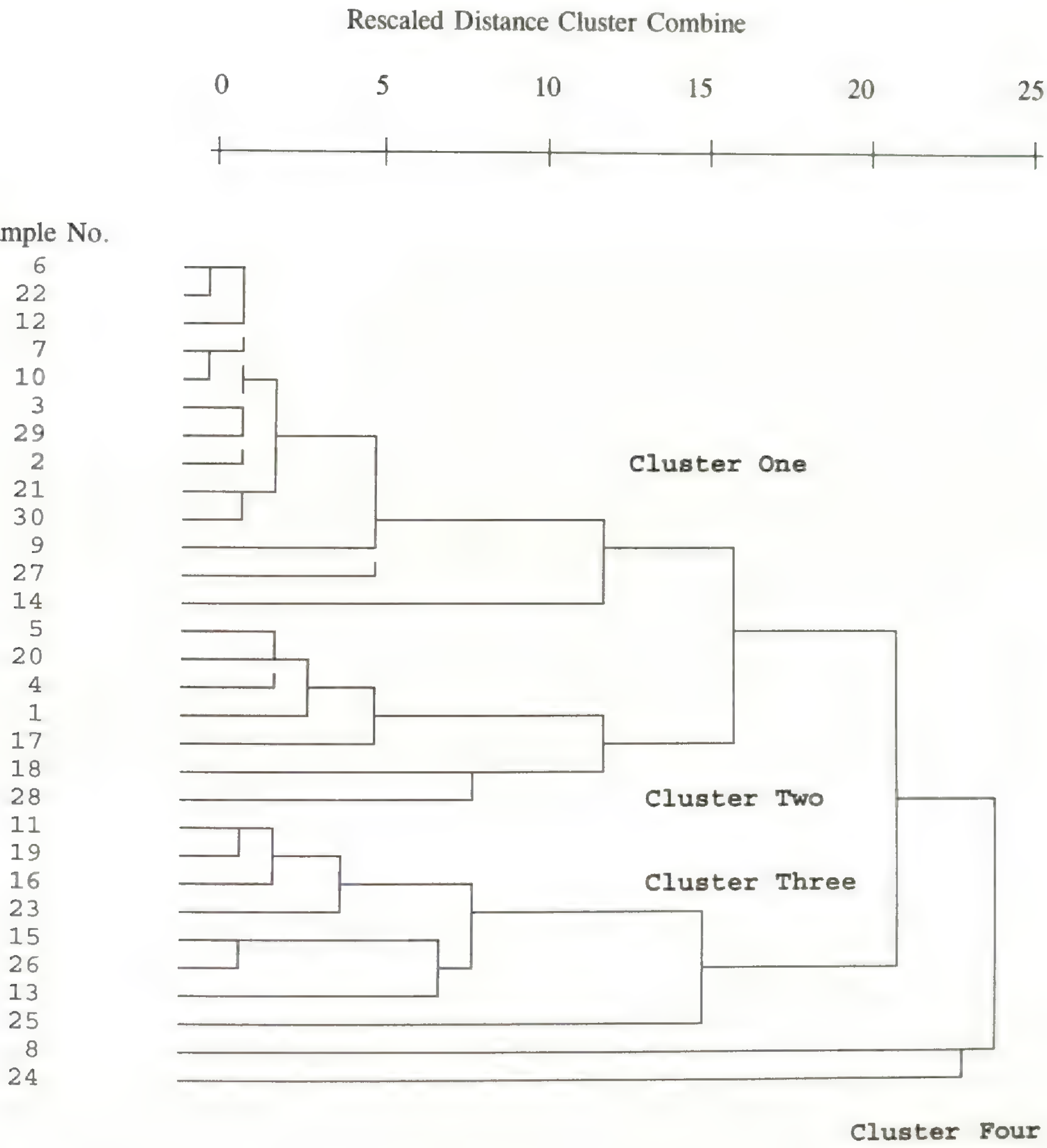


FIG. 2.—Dendrogram illustrating the clustering of coprolite constituents from the La Quinta site (CA-RIV-1179).

nological response) studies on coprolite matrix may be useful for addressing this possibility (e.g., Newman et al. 1993).

If one were to view the fish remains as evidence for consumption of stored foods, a late winter/early spring season of deposition may be indicated. The presence of chuckwalla remains suggests spring or later (Wallace 1978:109).

Cluster Three. Cluster Three (n = 8) is dominated by bonytail and unidentified fish remains (mostly charred); razorback sucker was not identified in the cluster. Tortoise and unidentified reptile are present, as is unidentified vertebrate bone. Cattail and bulrush seeds are often present, but only once in quantities considered abundant. Charcoal is present above trace amounts in each of the specimens.

In the Cluster Three samples, bonytail clearly is the primary identified resource consumed. Charcoal is relatively abundant in the specimens in this cluster and

many bones were charred (Farrell 1988:137). This suggests that fish were placed in an open fire to cook and consumed partially charred.

Bonytail remains from the midden, however, are mostly uncharred, suggesting that the fish were baked (Wilke and Sutton 1988:160). This indicates that bonytail were perhaps processed in one of two ways: (1) broiled with both meat and (charred) bone being consumed; or (2) baked with meat being removed and eaten and uncharred bones discarded.

Bulrush seeds (Farrell 1988:135) are consistently present in small quantities in the Cluster Three samples and may have been consumed in conjunction with bonytail. Bulrush produces seeds between May and August (Munz 1974:902), overlapping occurrence with cattail, although Farrell (1988:135) thought that bulrush was stored and then eaten with cattail. Bulrush formed a major constituent in some coprolites from Myoma Dunes (Wilke 1978).

Cluster Four. The fourth cluster (n = 2) contains abundant razorback and unidentified fish remains, bonytail not being identified in either specimen. Charcoal also is present in greater than trace amounts. Cattail seed is abundant in one of the specimens.

The general absence of razorback suckers in the coprolites is interesting since they are much more common in the general midden (Follett 1988). Suckers contain a large number of small bones and may have been processed differently than bonytail (e.g., filleted and broiled instead of baked whole; see McGinnis 1984:294 for observations in this regard). Thus, it is possible that razorback was a more important resource than indicated in the coprolites.

Discussion. Fish remains were consistently present in all samples although their abundance and condition (identification) varied considerably. Even if whole fish are consumed, most bone is digested (i.e., 90%; Jones 1986:55) and so not present in the visual elements of a coprolite. While this certainly impacts absolute values of fish bone abundance, it is the working assumption here that relative values are unaffected.

Several patterns are apparent in the coprolite evidence from CA-RIV-1179. First, it is clear that diet was not uniform but varied, likely on a seasonal basis. Second, the importance of fish (and other aquatic) resources appears to have changed seasonally, in spite of the presumed constant availability of fish (seasonal availability, if any, of specific fish is unknown).

Several combinations of resources were noted, forming, perhaps, the remains of "meals." Cattail (pollen, either alone or with flower heads) appears to have been consumed largely alone. Terrestrial animals seem not to have been consumed in meals with cattail, although some fish (mostly unidentified) was included. In addition, bulrush often was identified in specimens containing bonytail.

Fish, commonly viewed as a staple and perhaps even an everyday resource (e.g., Wilke 1978; Farrell 1988), appear to have formed a secondary dietary constituent during at least that portion of the year when cattail was consumed. Bonytail seems to have been the preferred fish, although razorback occasionally was obtained (the same pattern existed at Myoma Dunes Bed A; Wilke 1978:82). However, if razorback were filleted, that may account for the absence of its bones in the samples.

TABLE 2.—Floral remains from the midden recovered by flotation, CA-RIV-1179 (from Swope 1988: Table 22).

| Origin | Cat. No. | Species |
|---|---|---|
| Hearth 1 | 108-4-6A | *Chenopodium, Juncus, Oligomeris linifolia, Prosopis glandulosa* var. *torreyana, Scirpus acutus, Scirpus, Sesuvium verrucosum,* unidentified |
| Hearth 2 | 108-4-33 | *Chenopodium, Scirpus acutus, Scirpus validus, Sesuvium verrucosum* |
| Hearth 3 | 108-8-9A | *Chenopodium, Juncus, Oligomeris linifolia, Prosopis glandulosa* var. *torreyana, Scirpus acutus, Scirpus validus, Sesuvium verrucosum,* unidentified |
| Hearth 4 | 108-17-56 | *Chenopodium, Juncus, Scirpus acutus, Scirpus validus, Sesuvium verrucosum,* unidentified |
| Hearth 5 | 108-8-21 | *Amaranthus, Juncus, Prosopis glandulosa* var. *torreyana, Scirpus acutus, Scirpus validus, Sesuvium verrucosum, Typha* |
| Hearth 6 | 108-8-29 | *Scirpus acutus,* unidentified |
| Hearth 7 | 108-12-25 | *Scirpus* |
| Hearth 8 | 108-12-27 | *Chenopodium, Scirpus acutus, Sesuvium verrucosum* |
| " | 108-12-34 | *Scirpus acutus,* unidentified |
| Hearth 9 | 108-14-33 | *Scirpus acutus* |
| Soil Sample | 108-16-73 | *Chenopodium, Juncus, Scirpus acutus, Scirpus validus, Sesuvium verrucosum* |
| Soil Sample A | 108-19-21 | *Chenopodium, Juncus, Scirpus acutus, Sesuvium verrucosum* |

Razorback was not identified in the same coprolite as bonytail. This is somewhat intriguing since razorback is the larger fish (McGinnis 1984:148, 166). The historic Indian tribes of the lower Colorado River considered razorback a primary food fish (Castetter and Bell 1951:219) and procured them using the bow and arrow, nets, hook and line, and basketry traps (Castetter and Bell 1951:220–222). It is possible that razorback and bonytail were taken at different times, places, and/or with different methods.

Cluster Two contained few identified remains but considerable unidentified fish bone. It may be that processed fish (possibly dried fillets) formed the basis of these meals. Included, perhaps, might be other resources unidentifiable with standard analytical techniques, such as large mammals.

*Other dietary evidence.*—Dietary evidence from the remainder of the La Quinta site consists of floral and faunal materials recovered from the excavations. The macrofloral remains from the site (Table 2) include the same species found in the coprolites. However, several plants were found in the excavation samples that were not discovered in the coprolites, notably *Oligomeris,* rush *(Juncus),* and purslane *(Sesuvium).* Their absence in the coprolite sample is unexplained at this time.

TABLE 3.—Terrestrial and avian faunal remains recovered from the midden at CA-RIV-1179 (from Sutton and Yohe 1988: Table 19)[1]

| Scientific Name | 0–10 | 10–20 | 20–30 | 30–40 | 40–50 | 50–60 | 60–70 | 70–80 | 80–90 | Cremation | Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Xerobates agassizii* | 2 | 2 | 1 | — | — | — | — | — | — | — | 5 |
| *Diposaurus dorsalis* | — | 1 | — | — | — | — | — | — | — | — | 1 |
| *Sauromalus obesus* | — | — | 3 | — | — | — | — | — | — | — | 3 |
| Order Podicipediformes | 1 | — | 1 | — | — | — | — | — | — | — | 2 |
| *Pelecanus* cf. *erythrorhynchos* | — | — | 1 | — | — | — | — | — | — | — | 1 |
| Anatidae | — | 2 | — | — | — | — | — | — | — | — | 2 |
| *Anas* sp. | — | — | — | — | — | — | — | — | 1 | — | 1 |
| *Fulica americana* | 4 | — | — | — | — | — | — | — | — | — | 4 |
| unident. bird | 22 | 12 | 18 | 2 | — | 2 | — | 1 | — | 1 | 58 |
| *Sylvilagus audubonii* | 5 | — | — | — | — | — | — | — | — | — | 5 |
| *Lepus californicus* | 4 | 4 | 1 | — | — | — | — | — | — | — | 9 |
| unident. lagomorph | 31 | 31 | 10 | 7 | 1 | — | — | 2 | — | — | 82 |
| *Perognathus* sp. | 1 | — | 1 | — | — | — | — | — | — | — | 2 |
| *Dipodomys* sp. | 2 | — | — | — | — | 1 | — | — | — | — | 3 |
| *Neotoma* sp. | 1 | — | — | — | 1 | — | — | — | — | — | 2 |
| *Microtus californicus* | — | — | — | — | 1 | — | — | — | — | — | 1 |
| unident. rodent | 4 | 14 | — | 4 | — | 1 | — | — | — | — | 23 |
| *Canis latrans* | 5 | — | — | 3 | — | — | — | — | — | — | 8 |
| *Ovis canadensis* | 3 | 3 | 4 | — | — | — | — | — | — | 4 | 14 |
| unident. artiodactyl | 3 | — | 1 | — | — | — | — | 1 | — | 4 | 9 |
| unident. mammal | 100 | 40 | 31 | 14 | 2 | 2 | — | — | — | — | 189 |
| Totals | 188 | 109 | 72 | 30 | 5 | 6 | — | 4 | 1 | 9[2] | 424 |

[1]All units, depth in cm.

[2]Includes eight awls (all artiodactyl).

Faunal remains (Table 3) revealed the presence (and presumed consumption) of several resources not identified in the coprolites, notably bighorn sheep and waterfowl. In addition, razorback remains were much more common in the midden than in the coprolites, as noted above, suggesting that a bone removal process was involved in the preparation of razorback. Of interest is the sudden decrease in fish remains in the upper portion of the deposit, while the remains of other animals increase. Sutton and Yohe (1988:113) suggested that this drop in fish remains "might reflect the decreasing availability of fish in conjunction with the desiccation of the lake, ca. A.D. 1500. It is [in] this later period that lagomorphs (mostly unidentified to genus) and birds (particularly quail) become the most numerous."

## A MODEL OF DIET AND SITE USE

Based on the above patterns and observations the following model of seasonality and diet at the La Quinta site is proposed.

*Spring.*—The site was first occupied in the spring, the inhabitants having come from an unidentified winter camp (possibly another lakeshore site such as Myoma Dunes). Small terrestrial animals and some fish were exploited. In addition, it is possible that larger land animals (e.g., bighorn sheep) were exploited but are not reflected in the coprolite constituents. A possible game diversion site, apparently for bighorn sheep, is located nearby (Sutton and Wilke 1988b). Perhaps people came to the site to harvest cattail (pollen and/or flower heads) and utilized other resources until the cattail was ready. When cattail pollen did become available (late spring/early summer), it was heavily exploited. Cattail pollen formed the bulk of the diet during that time with other resources, including fish, being of secondary importance.

*Summer.*—Cattail would have been exhausted in early to mid-summer, although some was perhaps stored. At that time fish and waterfowl were utilized, fish (primarily bonytail) in large quantities. The paucity of razorback in the coprolites, compared to its relative abundance in the midden, suggests a processing difference between razorback and bonytail.

Although fish formed the bulk of the summer diet, other animals and various plants were exploited and consumed. Some of these resources had to be obtained at somewhat distant localities, perhaps by special purpose task groups. Being located in an ecotone, the La Quinta site would have offered a variety of localized resource opportunities, perhaps making such trips relatively infrequent.

*Fall/Winter.*—There is no evidence that the site was occupied during the fall or winter. Desert dicoria *(Dicoria canescens),* a winter staple (Wilke 1978:85), is largely absent in the coprolites, as are other resources thought to have formed part of the fall and winter diet (e.g., pinyon and mesquite; Wilke 1978:87).

Thus, the inhabitants of La Quinta likely moved to another residential base camp(s) for the fall and winter. The location of such camps is unknown but might be in the uplands and/or another lakeshore location. A winter occupation is indicated at Myoma Dunes, for example (Wilke 1978).

*Discussion.*—There are a number of questions that could not be addressed with the current (i.e., the "visible") data. For example, if bonytail were being processed in two different ways (baked versus broiled) it would result in a differential distribution of faunal elements in the coprolite samples. While bonytail bone would not be present in some samples, the presence of bonytail protein may be detectable using the immunological technique (e.g., Hyland et al. 1990). The same technique may be utilized to test for presence of other animal meats, such as deer or mountain sheep, as the bones of such animals would not likely be present in identifiable fragments in a coprolite. With this general problem in mind, six coprolites from the CA-RIV-3682 site were tested for immunological response. Although the results were negative, the identifiable species list currently is quite limited (Newman et al. 1993).

## LATE PERIOD SETTLEMENT AND SUBSISTENCE ALONG NORTHERN LAKE CAHUILLA

Wilke (1978:103) proposed a changing settlement-subsistence model for the late prehistoric of the northern Lake Cahuila basin. The model was based primarily on coprolite data from Myoma Dunes and ethnographic analogy, there being few other data available. That situation is still largely true, except for the results from La Quinta. While the La Quinta dietary and seasonality data come only from one site, they suggest that some revisions in the Wilke model may be in order.

Wilke (1978) suggested that prior to the final desiccation of Lake Cahuilla (ca. A.D. 1500), a settlement/subsistence system operated which was characterized by permanent villages along the lakeshore for exploiting aquatic resources coupled with temporary seasonal camps used to exploit upland resources. After desiccation, the environment changed to the desert conditions of today. The settlement-subsistence pattern remained basically the same (permanent villages; i.e., Bean 1978:575) but was centered on permanent springs rather than the lakeshore. The economic focus shifted from aquatic resources to terrestrial resources, likely resulting in increasing utilization of the surrounding uplands and a population increase in those areas (Wilke 1978:113).

The La Quinta site was interpreted as a camp and not a permanent lakeshore village like Myoma Dunes (Wilke and Sutton 1988a:162). This interpretation was based on the seasonality of ecofactual materials. The site was viewed as being a part of a "settlement-subsistence system centered in the Salton Basin around Lake Cahuilla" (Wilke and Sutton 1988a:163) rather than one centered on upland resources (cf. Weide 1976).

Given this interpretation, the La Quinta site does not fit into the settlement-subsistence system proposed by Wilke (1978) for the final lakestand. Nor does the site fall within the parameters of a postlake adaptive system, i.e., like the historic Cahuilla. There are at least two possible explanations for this pattern. First, it may date from the very end of the last lakestand and reflect a transitional system, the adaptation to the change between lake and desert environments. Second, it may simply represent a heretofore undefined segment of the lakeshore system proposed by Wilke (1978). Whatever the case, the pattern at La Quinta is different than that found at Myoma Dunes or that of the historic Cahuilla.

I suggest that the La Quinta site is part of a transitional system; the following factors support this view. First, the site dates to the very end of the last lakestand (Sutton 1988:51), a time when such a transitional system would be expected. Second, the faunal data (Sutton and Yohe 1988:113) suggest that fish declined in importance and that other, nonaquatic, resources became more important later in time. Third, there is evidence that the La Quinta site served as a base camp, rather than as a special purpose camp, since the distribution of bighorn sheep remains suggests that those animals were butchered elsewhere and taken to the La Quinta site (Sutton and Yohe 1988:112).

That aquatic resources still are quite prominent at La Quinta suggests that the site reflects the early part of such a transitional system. At some point in time, the shoreline receded away from La Quinta and other camps were established at

lower elevations to remain close to the retreating lake. The later aspects of the transitional system would be represented at those sites, none of which have been identified and investigated.

## CONCLUSIONS

People living around Lake Cahuilla at the time of its final stand (ca. A.D. 1500) functioned within a complex system of seasonal resource use and changing settlement. There is little doubt that people camped near the lake to exploit the resources present there (e.g., fish, cattail, and waterfowl). It has been commonly assumed that in those situations fish was the dominant faunal food resource and that other animals were of secondary importance.

Several interesting observations can be made from the analysis of coprolite and other dietary data. First, fish were apparently not a primary resource at all times while people were at the lake and terrestrial animals were more important at lakeside sites that previously thought. Second, cattail was very heavily exploited when available, perhaps to the exclusion of other resources for that short time.

At a gross level, the La Quinta coprolite data appear to be relatively homogeneous (i.e., fish in every sample, cattail in most). However, significant patterns do exist in the clustering of constituents. Analyses of constituent distributions and clustering can add considerable detail to the understanding of human ecology and adaptation.

By combining the analyses of multiple lines of dietary evidence, it is possible to record and analyze dietary patterns that provide considerable information regarding people in antiquity. In addition to general dietary constituents, the reconstruction of cuisine, pharmacology, and other patterns are possible. I hope that this line of research has only begun.

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## BOOK REVIEW

**Delfina Cuero: Her Autobiography: An Account of Her Last Years and Her Ethnobotanic Contributions.** Florence Connolly Shipek. Menlo Park, California: Ballena Press, 1991. Pp. iii, 101. $19.50 (hardcover), $12.50 (paperback). ISBN 0–87919–123–6 (hardcover), 0–87919–122–8 (paperback).

As Ballena Press Anthropological Paper No. 38, this small book includes Delfina Cuero's autobiography, which was published originally in 1968, plus such new material as an account of her life from 1968 to 1972, a partial listing of her ethnobotanical contributions, two photographs, and a map of southwestern California and adjacent Baja California. Delfina Cuero was a Diegueño Indian, or Kumeyaay, who was born about 1900 and lived in San Diego County and nearby northern Baja California Norte until her death in 1972. Her perspective on the use of and change in the landscape and natural resources of the area as well as the data on specific plants are the two distinct contributions of major interest to ethnobotanists.

The importance of the collection, consumption and storage of plants and ani-

mals to the survival of non-reservation Indians before and during the acculturation period is clearly stated. The effect of cultural ignorance and violation of legal agreements on her people, as documented by Delfina Cuero's personal experiences, is dramatically presented by such examples as the division of hunting and gathering territories by land developers and two countries, and the negative impact of cessation of female initiation ceremonies on such activities as traditional plant use and human reproduction. The correlation is evident between cultural disintegration and habitat loss.

The 70 taxa listed at the end of the book are part of a larger work on the ethnobotany of Kumeyaay which is being prepared by Dr. Shipek. This particular set of data originated solely from Delfina Cuero during separate visits to Mission Bay Salt Marsh Reserve and Torrey Pines State Park in 1966 and 1968, respectively, both in coastal southern California. It is included because she was the only person who provided such information and it is a testimony to her contribution. Most of the entries have basic information but four plants have no use listed and 15 are without native names.

The utility of the plants is illustrated by 48 species with a single use and 18 with multiple uses. The ethnocentric categories are broken down as follows: medicine 40, food 28, soap 4, beverage 4, personal adornment 2, utilitarian 2, flavoring 2, smoking substance 1, thirst reliever 1, animal food 1, fiber 1, and construction material 1. Unfortunately, no voucher specimens were obtained. Plant identification was made in the field using P.A. Munz' *A Flora of Southern California* (1974) although this book was published after the field trips. In a few cases, the taxonomic nomenclature of the ethnobotanical list does not correspond to that in the flora. At least nine plants are introduced, which may represent resource experimentation as part of acculturation (e.g., *Brassica nigra* which is known by the Kumeyaay generic name for "edible greens" and *Avena fatua* which replaced an unidentified semi-domesticated grain). The lack of voucher specimens and the hiatus between Delfina Cuero's use of certain plants as a young woman and her reacquaintance with them many years later may be of concern to researchers who are interested in the reliability of this information. None-the-less Florence Connolly Shipek and her collaborators, Mrs. Rosalie Pinto Robertson, Dr. Margaret Langdon, and Mrs. Elisabeth C. Norland, are to be congratulated on bringing to the ethnobotanical community a tantalizing ethnobotanical compilation with a strong personal background of the Kumeyaay collaborator. Most of all, we have a special appreciation of Delfina Cuero for having shared her life and ethnobotanical experiences with us. The historical perspective in this book puts into painful perspective the destruction of a people, their knowledge and their plants.

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Robert Bye
Jardín Botánico, Instituto de Biología
Universidad Nacional Autónoma de México
04510 México, DF, MEXICO

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# NEW PERSPECTIVES ON A WILD GOURD IN EASTERN NORTH AMERICA

C. WESLEY COWAN
*Curator of Archaeology*
*Cincinnati Museum of Natural History*
*1720 Gilbert Ave.*
*Cincinnati, Ohio 45202*

BRUCE D. SMITH
*Curator of North American Archaeology*
*National Museum of Natural History*
*Smithsonian Institution*
*Washington, D.C. 20560*

ABSTRACT.— Free-living *Cucurbita pepo* gourds have been documented in different areas in the temperate eastern woodlands since the first few decades of the 19th century. Until recently, however, little attention has been afforded these populations, and their potential role in the evolution of domesticated forms of *pepo* squashes has been obscured. This paper focuses on the botanical history of these free-living gourds, examines the availability of cultivar ornamental gourds to 19th century American gardeners, and summarizes habitat information for contemporary populations in several areas in the East. Important morphological measurements from both contemporary free-living and cultivar *pepo* gourd populations as well as archaeological specimens are compared. Combined, these data suggest that free-living *Cucurbita pepo* gourds are ancient members of an eastern flora, and could well be the progenitors of some domesticated squashes.

RESUMEN.— Desde las primeras décadas del siglo XIX se ha documentado la existencia de calabazos no cultivados de la especie *Cucurbita pepo* en diferentes áreas de los bosques templados del este de los Estados Unidos de Norteamérica. Sin embargo, hasta hace poco se les había otorgado poca atención a estas poblaciones, y su papel potencial en la evolución de las formas domesticadas de la calabaza *pepo* ha sido difícil de discernir. Este trabajo se enfoca a la historia botánica de estos calabazos no cultivados; examina la disponibilidad de cultivares de calabazos ornamentales para los jardineros norteamericanos en el siglo XIX, y resume la información sobre el hábitat de las poblaciones contemporáneas en varias áreas del oriente de los Estados Unidos. Se comparan mediciones morfológicas importantes tanto de poblaciones contemporáneas cultivadas y no cultivadas de calabazos *pepo,* como de especímenes arqueológicos. Estos datos combinados sugieren que los calabazos no cultivados de *Cucurbita pepo* son miembros antigous de la flora del este de Norteamérica, y bien podrían ser los progenitores de algunas calabazas domesticadas.

RÉSUMÉ.— L'existence des gourdes sauvages *Cucurbita pepo* a été documentée dans plusieurs endroits des régions boisées tempérées de l'Est depuis les pre-

mières décénies du 19ème siècle. Jusqu'à récemment toutefois, on a prété peu d'attention à ces populations locales, et leur rôle possible dans l'évolution des formes cultivées de la courge *pepo* n'a pas été suggéré. Cet essais est consacré à l'histoire botanique de ces gourdes sauvages. Il examine l'accès des jardiniers américains du 19ème siècle à la forme cultivée des gourdes ornementales, et synthétise les informations sur l'habitat des populations contemporaines dans plusieurs régions de l'Est. D'importantes mesures morphologiques des espèces sauvages et des populations cultivées de la gourde *pepo* contemporaine ainsi que des specimens archéologiques sont comparés. Vues dans leur ensemble, ces données suggèrent que les gourdes *Cucurbita pepo* sauvages sont des ancients membres de la flore orientale, et pourraient parfaitement avoir été les progéniteurs de certaines espèces de courges cultivées.

. . . Is this Texas cucurbit a garden escape as suggested by Gray, or is it the prototype from whence came the numerous cultivated forms of *Cucurbita pepo*? Is it an indigene or a foreigner?

(A.T. Erwin 1938:253)

## INTRODUCTION

In a little recognized and rarely referenced article, A.T. Erwin first posed a question that remains of central importance in documenting eastern North America as an independent center of plant domestication. As might be expected, the question has become more complex and has expanded in scope over the intervening years, but it still involves the status of the Texas wild gourd and related free-living gourds of eastern North America as wild plant versus garden escape, and their possible role as a progenitor in the independent domestication of *Cucurbita pepo* in the eastern woodlands.[1]

The Texas wild gourd grows today along rivers and streams in eastern Texas, and related free-living populations of gourds (able to survive outside of cultivation) are being documented in increasing numbers in other areas of eastern North America. In addition, since the 1980s, rind fragments and seeds of a similar gourd have been recovered from archaeological deposits in eastern North America that predate the earliest evidence of domestication of indigenous seed plants by 2500 years (Smith et al. 1992; Cowan 1990). Over the past decade both these present-day and prehistoric gourds have been the topic of considerable discussion. Do the early *Cucurbita pepo* gourds of the East that predate the circa 4500–3500 B.P. domestication of local plants represent a wild plant indigenous to the region, or an early domesticate introduced from Mexico? If these pre-4500 B.P. gourds can be traced back to Mesoamerica, then agricultural developments in the East might be considered derivative rather than independent, since a tropical crop plant would have arrived in advance of domestication of local species. On the other hand, if these early cucurbits represent an indigenous wild gourd, then there can be little doubt that eastern North America could have been an independent center of plant domestication. The debate regarding these early gourds has added new significance to a long-standing discussion of present-day free-living *C. pepo* gourd populations in eastern North America: do they represent an indigenous wild gourd, or

the recent escape from cultivation of a domesticate that ultimately originated in Mesoamerica?

Intertwined with and overlaying these questions is the possibility that *C. pepo* was independently domesticated in eastern North America a full 5000 years after it was first domesticated in Mexico (Flannery 1986). Based on available archaeological evidence for the earliest clearly domesticated *C. pepo* in the East (4000–3000 B.P.), this second episode of domestication would have occurred at the same time as other seed crops were brought under domestication.

Recent biochemical analyses of cultivar and wild populations of *Cucurbita pepo* lend support to the role a wild eastern squash may have had in the domestication process. Isozyme studies indicate two distinct lineages characterize *C. pepo* (Decker-Walters 1990; Decker 1988; Decker and Wilson 1986, 1987; Wilson 1990). One of these seems to have evolved in Mexico, the other in eastern North America. The Mexican lineage contains the marrows and pumpkins while the eastern counterpart includes the crooknecks, acorns, and most cultivated ornamental gourds. The free-living gourds from various areas in the southeast are also part of this lineage. And like many other domesticated members of the lineage, the free-living gourds are vining, monoecious annuals that produce large insect pollinated flowers. They are easily recognizable in the wild by their distinctive sinuously lobed leaves, yellow flowers, and ivory or green striped fruits.

Elsewhere (Smith et al. 1992) we have summarized the theoretical arguments of the proponents of a single Mesoamerican origin for *C. pepo* and those who believe *C. pepo* squash may have been domesticated separately in Mexico and eastern North America. Our purposes in this paper are fourfold: (1) to document the geographical distribution of modern free-living gourd populations in the East; (2) to establish the historic time depth of these gourds; (3) to describe their niche and habitat preferences in the Ozarks of Missouri and Arkansas; and (4) to describe the morphological characteristics of fruits of these populations. The following discussion will make it clear that wild gourds are not limited in distribution to Texas, that the more widely distributed gourd represents an ancient member of an eastern flora, and that the ancestral relationship of this wild gourd to cultivated forms of *Cucurbita pepo* can be partially untangled by a comparison of modern and archaeological collections (see also Decker-Walters et al. and Newsom et al. this volume).

## DOCUMENTING THE GEOGRAPHICAL RANGE OF FREE-LIVING GOURDS IN THE MIDWEST AND SOUTHEAST

Free-living populations of *Cucurbita* gourds in eastern North America have been collected for over 150 years. In addition to those in eastern Texas recognized in the 1830s, specimens were also collected in the 1840s as far north as St. Louis, Missouri. Although the specific status of the plant is uncertain, wild gourds may also have been identified in peninsular Florida near the beginning of the last quarter of the nineteenth century (see below). By and large, however, with the exception of discussions of the Texas wild gourd (*Cucurbita pepo* ssp. *ovifera* var. *texana*) these populations have been afforded little importance by most profes-

sional botanists. Until recently, their role in the evolution of cultivated forms of *Cucurbita pepo* has been assumed to be negligible.

Until the mid-1980s relatively little attention was focused on *C. pepo* gourd populations outside of Texas, likely because they were assumed to be ephemeral escapes from cultivation (Asch and Asch 1985:157; Heiser 1985:16–17). Julian Steyermark appears to have played an important role in establishing that free-living *C. pepo* gourds outside of Texas were a legitimate target for collection. He collected specimens from southwest Missouri in the 1950s, distributed herbarium sheets of the plants to other institutions, and included a distribution map and plant illustration in his landmark publication *Flora of Missouri* (Steyermark 1963). Steyermark's inclusion of this gourd seems to have encouraged other botanists to collect it, and led to its addition to other state floras. In Illinois, for example, it is absent from a 1955 survey (Jones and Fuller 1955) yet is documented as present in seven counties in the next published atlas (Mohlenbrock and Ladd 1977). Similarly, while it goes unmentioned in earlier surveys, "*C. pepo* ssp. *ovifera*" is recorded in 10 Arkansas counties in Edwin Smith's 1978 state atlas (E. Smith 1978, 1988), with many of the relevant herbarium specimens collected in the mid-1970s.

Another important impetus to the collecting and documentation of free-living gourd populations outside of Texas came in the mid-1980s when Decker-Walters included gourds from Illinois, Arkansas, and Alabama in her dissertation research on the taxonomy and evolution of *C. pepo* and proposed that these var. *texana*-like geographical outliers might represent relict populations of a wild indigenous gourd (Decker 1986). As a result of Decker-Walter's inclusion of these specimens, Heiser added them to his distribution map for var. *texana*, expanding it to encompass the "distribution of *C. texana* and plants approaching *C. texana*" (Heiser 1989:473). Similarly, Michael Nee included eastern free-living outliers recorded for Missouri (Steyermark 1963), Illinois (Mohlenbrock and Ladd 1977), Arkansas (E. Smith 1988), and Alabama on his geographical range map for var. *texana*, with the caption note that "some dots outside of Texas may represent feral *C. pepo*" (Nee 1990:61). Decker-Walter's research, and the subsequent mapping efforts of Heiser and Nee, marked an important shift in that they considered both Texas and "outlier" populations of var. *texana* and began to chart the full geographical distribution of free-living *Cucurbita pepo* gourds in the southern and eastern United States.

Building on these studies, we began a more concerted effort in the fall of 1990 to establish the range of free-living *Cucurbita pepo* gourds. Herbaria were canvased regarding accessions of "escapes" of *Cucurbita* (often listed as *C. pepo* ssp. *ovifera*), colleagues were questioned regarding sightings of free-living gourds, and an initial survey of drainages in the eastern Missouri and Arkansas Ozarks was conducted in November of 1990, complementing the surveys carried out by Michael P. Hoffman and his students in the western Ozarks over the past several years (see Smith et al. 1992). The initial results of this distributional study are shown in Fig. 1 and summarized in Table 1. Outside of Texas, 26 county records were added to the 29 previously documented, and fruits were collected from over 30 locations in seven states (Table 1). Within Texas, gourd populations were documented in 20 counties.

Based on our survey, the primary present-day geographical range of free-living *Cucurbita pepo* gourds west of the Mississippi River extends in a broad north-south band from south-central Texas to central Illinois. Stretching for more than

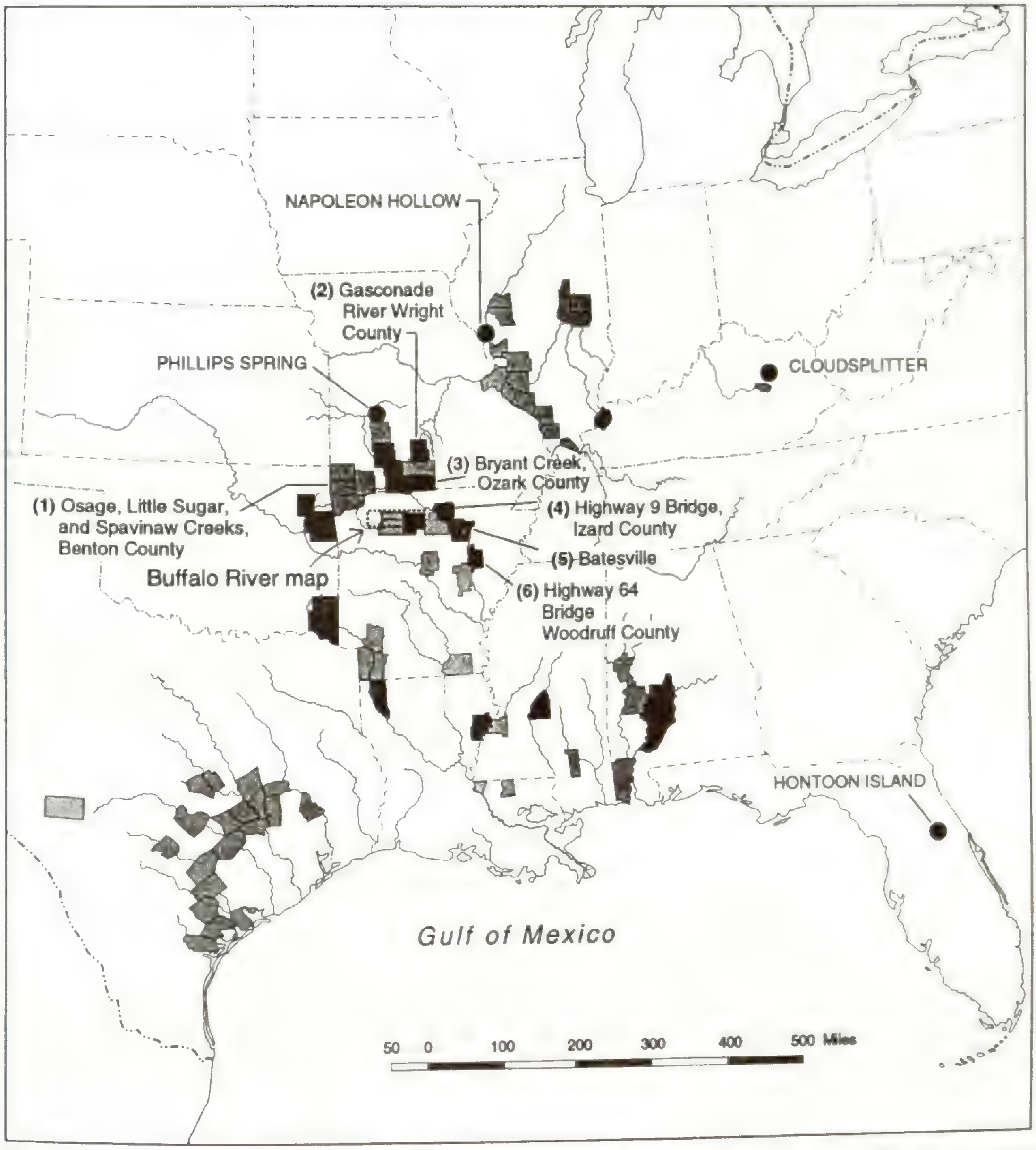


FIG. 1.—Current distribution of free-ranging *Cucurbita pepo* gourds in eastern North America based upon field studies and herbaria records. Dark shaded areas denote counties where field collections were made in 1990–91. Lighter shaded areas denote counties where herbaria records exist.

1,400 kilometers (900 miles) this north-south band appears to be divided into five subareas. In the large Texas subarea populations are documented throughout much of the drainage catchment of the eastern part of the state, occurring in all of the southeastern flowing rivers that enter the gulf of Mexico between Corpus Christi and Galveston (the Nueces, San Antonio, Guadalupe, Colorado, Brazos, and Trinity rivers). An absence of populations to date from the Neches and Sabine drainages separates the Texas subarea from populations documented along the Red River and lower Ouachita River in Arkansas. A similar absence of recorded populations within the Ouachita mountains of west-central Arkansas separates

TABLE 1.—Geographical distribution, by county, of free-living *Cucurbita pepo* gourds in eastern North America.[1]

| County | Collector | Year | Herbarium | Reference |
|---|---|---|---|---|
| **ALABAMA** | | | | |
| Dallas | C. Sheldon | 1988 | | this study |
| Greene | M.L. Roberts | 1982 | Alabama | |
| Greene | | | | Decker 1986 |
| Marengo | | | | Decker 1986 |
| Mobile | R. Deramus | 1966 | Alabama | |
| Monroe | C. Sheldon | 1988 | | this study |
| Wilcox | R. Haynes | 1978 | Alabama | |
| Wilcox | C. Sheldon | 1988 | | this study |
| **ARKANSAS** | | | | |
| Ashley | | | | Smith 1988 |
| Benton | M. Hoffman | 1990 | | this study |
| Benton | D. Dickson | 1990 | | this study |
| Benton | E. McCollum | 1990 | | this study |
| Faulkner | D. Oliver | 1975 | Arkansas | Smith 1988 |
| Hempstead | S. Harrison | 1976 | Arkansas | Smith 1988 |
| Independence | | | | Smith 1988 |
| Independence | Smith and Cowan | 1990 | | this study |
| Izard | | | | Smith 1988 |
| Miller | | | | Smith 1988 |
| Newton | | | | Decker 1986 |
| Prairie | D. Oliver | 1975 | Arkansas | Smith 1988 |
| Searcy | B. Hinterthuer | 1977 | Arkansas | Smith 1988 |
| Searcy | Smith and Cowan | 1990 | | this study |
| Stone | | | | Smith 1988 |
| Woodruff | Smith and Cowan | 1990 | | this study |
| **ILLINOIS** | | | | |
| Cass | | | | Mohlenbrock and Ladd 1977 |
| Coles | | | | Mohlenbrock and Ladd 1977 |
| Douglas | G. Jones | 1966 | Illinois | |
| Douglas | G. Jones | 1966 | Florida | |
| Jackson | | | | Mohlenbrock and Ladd 1977 |
| Jersey | G. Fritz | 1990 | | this study |
| Madison | | | | Mohlenbrock and Ladd 1977 |
| Massac | R. Mohlenbrock | 1986 | | |
| Morgan | | | | Mohlenbrock and Ladd 1977 |
| Piatt | | | | Mohlenbrock and Ladd 1977 |
| Randolph | | | | Decker 1986 |
| St. Clair? | W. Welsch | 1862 | Illinois | |
| St. Clair | H. Eggert | 1875 | Missouri | |
| St. Clair | H. Eggert | 1876 | Texas | |
| St. Clair | H. Eggert | 1892 | Missouri | |
| St. Clair | H. Eggert | 1893 | Harvard | |
| St. Clair | H. Eggert | 1893 | Missouri | |
| St. Clair | J. Kellogg | 1901 | Missouri | |
| Union | | | | Mohlenbrock and Ladd 1977 |

| County | Collector | Year | Herbarium | Reference |
|---|---|---|---|---|
| **KENTUCKY** | | | | |
| Powell | W. Booth | 1990 | | this study |
| **LOUISIANA** | | | | |
| Bossier | L. Baker | 1990 | | this study |
| St. Helena | C. Allen | 1971 | LSU | |
| Tensas | G. Fritz | 1990 | | this study |
| W. Feliciana | A. Martin | 1972 | LSU | |
| **MISSISSIPPI** | | | | |
| Claiborne | K. Rogers | 1978 | Tennessee | |
| Forrest | K. Rogers | 1971 | Tennessee | |
| Rankin | S. Jones | 1970 | Georgia | |
| **MISSOURI** | | | | |
| Barry | J. Steyermark | 1955 | Missouri | Steyermark 1963 |
| Christian | | 1990 | | this study |
| Douglas | J. Steyermark | 1957 | Georgia | Steyermark 1963 |
| Greene | Smith and Cowan | 1990 | | this study |
| Howell | | | | Steyermark 1963 |
| McDonald | | | | Steyermark 1963 |
| Newton | | | | Steyermark 1963 |
| Ozark | Smith and Cowan | 1990 | | this study |
| Polk | Smith and Cowan | 1990 | | this study |
| St. Louis | G. Engelmann | 1846 | Missouri | Steyermark 1963 |
| St. Louis | G. Engelmann | 1846 | Missouri | |
| St. Louis | Muehlenbach | 1961 | Missouri | |
| St. Louis | Muehlenbach | 1964 | Missouri | |
| St. Louis | Muehlenbach | 1972 | Missouri | |
| Taney | | 1990 | | this study |
| Texas | J. Steyermark | 1956 | Harvard | Steyermark 1963 |
| Wright | Smith and Cowan | 1990 | | this study |
| **OKLAHOMA** | | | | |
| Adair | M. Hoffmann | 1990 | | this study |
| Cherokee | B. Meyer | 1990 | | this study |
| Mayes | D. Dickson | 1990 | | this study |
| **TEXAS** | | | | |
| Bell | Mahler 1988 | | | |
| Brazos | D.S. Correll | | Texas | |
| Brazos | | | | Decker 1986 |
| Burleson | | | | Decker 1986 |
| Calhoun | Harman and Smith | | Texas | |
| Comal | Lindheimer | | Texas | |
| DeWitt | D.S. Correll | 1962 | SWLS | |
| DeWitt | D.S. Correll | | Texas | |
| DeWitt | Tharp | | Texas | |
| Fayette | | | | Decker 1986 |
| Goliad | | | | Decker 1986 |
| Gonzales | | | | Decker 1986 |
| Gonzales | | | | Decker 1986 |
| Grimes | | | | Decker 1986 |

TABLE 1.—Geographical distribution, by county, of free-living *Cucurbita pepo* gourds in eastern North America.[1] (continued)

| County | Collector | Year | Herbarium | Reference |
|---|---|---|---|---|
| **TEXAS** (continued) | | | | |
| Lee | | | | Decker 1986 |
| Madison | | | | Decker 1986 |
| Refugio | | | | Decker 1986 |
| Robertson | | | | Decker 1986 |
| San Jacinto | | | | Decker 1986 |
| San Patricio | | | | Jones 1975 |
| Sutton | Reed | | Texas | |
| Travis | A.T. Erwin | 1938 | | Erwin 1938 |
| Travis | Barkley | | Texas | |
| Travis | Tharp | | Texas | |
| Travis | Strandtmann | | Texas | |
| Washington | | | | Decker 1986 |

[1]Requests for information regarding free-living *C. pepo* specimens were sent to the following herbaria: University of Alabama, Auburn University, University of Arkansas, University of Florida, Florida State University, University of Georgia, Emory University, University of Illinois, Southern Illinois University, University of Kentucky, Indiana University, DePauw University, Louisiana State University, Southwest Louisiana State University, Harvard University, University of Mississippi, University of Missouri, Missouri Botanical Gardens, University of North Carolina, Duke University, University of Cincinnati, The Charleston Museum, The University of Tennessee, The University of Texas, Virginia Tech University, The University of West Virginia, National Museum of Natural History, Smithsonian Institution.

the as yet little surveyed Red River subarea from a major subarea located in the Ozark Plateau of southern Missouri and northern Arkansas. Within the Ozark Plateau, populations have been documented in small western trending streams and larger southern flowing rivers of the drainage system of the Arkansas River, as well as in north-flowing streams of the Osage and Gasconade systems, and along the east-southeastern flowing Buffalo-White River drainage system. About 150 kilometers separates the Ozarks subarea from the northernmost, Illinois subarea, which encompasses the lower Illinois River, the upper reaches of the Kaskaskia River, a 250 kilometer (150 mile) portion of the Mississippi River, and a small section of the lower Ohio River. A fifth subarea can be recognized along the central coastal plain of the Gulf of Mexico, with populations recorded along a number of major and minor drainage systems emptying into the Gulf, including those of the lower Mississippi, Pascagoula, Pearl, Mobile-Tombigbee, and Alabama Rivers.

While it is not possible to ascertain the degree to which these apparent internal subdivisions are real as opposed to simply reflecting an absence of active survey and collection, planned field research in these intervening areas, along with ongoing comparative genetic analysis of the populations of different subareas (see Decker-Walters et al., this volume), will provide a clearer picture of the degree of extant geographic and genetic separation that does exist. It would be fairly safe to predict, however, even given the nonuniform distribution of documented populations, that this eastern free-living *Cucurbita pepo* gourd today has a

largely unbroken distribution in river systems from south Texas as far north as central Illinois, and along the Gulf coastal plain from Corpus Christi to Mobile.

## CURRENT EXPLANATIONS FOR THE DISTRIBUTION OF FREE-LIVING *Cucurbita pepo* GOURDS

The time depth of the gourd in different areas of its current range is difficult to determine with certainty. Although gourds were observed in 1835 in Texas, their presence was not noted in the Ozarks until the mid-1950s, they seemingly went unrecorded in Illinois and along the Gulf coastal Plain until the mid-1960s, and were only documented along the Red River in the mid-1970s.

The distribution of gourd populations and the sequence of their initial collection (Table 1), are considered by some to indicate a rapid spread of a specialized agricultural weed associated with the post-World War II increasing importance of soybeans (Asch and Asch 1992). In this model, feral gourd populations are seen as occupying an extremely narrow niche—that of cultivated floodplain fields—in highly specialized agroecosystems.

There is little question that *Cucurbita pepo* gourds have become a problem weed in floodplain fields in the southeast and midwest. The extent to which they have become a pest in Arkansas and Louisiana is detailed by the publications describing efforts to control them (Oliver et al. 1983; Boyette et al. 1984). A recent study of herbicide effectiveness reported density counts ranging from 32 plants per square meter at Fulton, Arkansas, to 43 per square meter at Conway, Arkansas, to 129 plants per square meter at Garland, Arkansas (Oliver et al. 1983). In late November, 1990, thousands of free-living *pepo* gourds were observed in an "infested" bottomland cotton and soybean field located between the levee and Mississippi River near St. Joseph, in Tensas Parish, Louisiana (Gayle Fritz, personal communication, 1991). On a much smaller scale, several dozen gourds were collected in November of 1990 from fallow floodplain fields along Willow Chute, an old channel of the Red River just north of Shreveport (Bossier Parish) in northwest Louisiana (Frank Schambach, personal communication, 1990). In Kentucky, a free-living *Cucurbita pepo* gourd known locally as "Johnny Gourd" has grown in the Ohio and Green river floodplain fields of corn and soybeans of Union and Henderson Counties for years. When questioned about the age of the "Johnny Gourd" in this portion of Western Kentucky most farmers interviewed by the senior author scoffed at the idea of it being a recent phenomenon. Most indicated that free-living gourds were present long before World War II.

In our view a likely explanation for the seemingly shallow time depth for free-ranging *Cucurbita pepo* gourds outside of Texas may be explained by: (1) a lack of interest by botanists, and (2) the plant may be aggressively re-establishing itself in drainage systems that it had previously occupied, particularly east of the Mississippi River.

The Asches (1992) have also suggested that Texas wild gourd may have expanded its range to the east and north over the past 40 years as the result of agricultural commerce, dispersal by gourd hobbyists, or in packets of ornamental gourd seeds. These potential human vectors of dispersal, along with other possibilities, could well be involved in the continuing expansion of the range of free-

living *pepo* gourds in eastern North America. The suggestion that seeds of the wild Texas gourd were packaged and sold as ornamental gourds does, in fact, provide a context for the subsequent "escape" of an "ornamental gourd" across the East, but such events, if they occurred, would clearly have to be considered human mediated range extension of a still wild plant, rather than the escape of a domesticated plant. A related and intriguing question involves the possible existence of long established relict populations of *Cucurbita pepo* gourds outside Texas in areas minimally disturbed by humans and agroeconomies. Does the ongoing range extension of a wild gourd in the East have its origins only in Texas populations, or are there other source areas where relict populations have existed, largely unnoticed, for a long period of time?

In addition, the Asches discount the idea that a wild cucurbit might have been overlooked by nineteenth century plant explorers in the Mississippi Valley, suggesting that the showy vines and fruits would have been difficult to miss. In fact, there is ample reason to understand why botanists would have ignored the plants. As long as they were considered an "escape" from cultivation, there was little reason to study free-living gourds. There is, in addition, at least one other precedent from the East where a completely indigenous cucurbit remained unknown to the botanical world for hundreds of years. The Okeechobee gourd (*Cucurbita okeechobeensis*) was not formally described until the first few decades of this century (Small 1918, 1922, 1930). While Bartram described a seemingly wild gourd in northern Florida in 1774 (Harper 1958), it is impossible to determine whether this was the Okeechobee or the Texas gourd (Walters and Decker-Walters 1993). The fact that this plant escaped the attention of professional botanists is probably also a reflection of the entrenched belief that wild cucurbits simply do not exist in the East.

There are three straightforward tests of whether this ongoing range expansion of *Cucurbita pepo* gourds involves the radiation and re-establishment of a wild gourd in previously occupied territory, or the spread of a new weed into a narrow and recently created habitat of the agroeconomy. The first focuses on the Asches' (1992) new narrow niche floodplain field weed explanation. Especially significant in this regard are any indications that gourds were present beyond Texas prior to the post-World War II appearance of the soybean field agroecosystem habitat into which the ornamental gourds hypothetically escaped. Presence of free-living gourds in eastern North America prior to the late 1940s would clearly undermine the new soybean field habitat hypothesis.

An interrelated test focuses on availability of domesticated forms of ornamental gourds (*Cucurbita pepo* ssp. *ovifera*) to American gardeners. The Asches (and others before them) assert that contemporary free-ranging gourds in the Southeast and Midwest are garden escapes that have become naturalized. While suggesting this occurred after World War II, they do not specify which ornamentals escaped. It is important, then, to understand (1) when ornamental gourds began to be widely available to home gardeners, (2) what types were marketed, and (3) the context of their cultivation. If it can be shown, for example, that numerous ornamental gourd varieties were available to American gardeners for generations before World War II, and that the context of their use was extremely limited, then multiple early records of free-living gourds might be regarded as evidence of a truly wild *Cucurbita pepo* gourd population in the East long before the advent of highly mechanized farming.

A third test focuses on how tightly modern gourds are restricted to agricultural settings. Are they narrowly adapted weeds restricted to soybean field settings as proposed by the Asches? Are they tightly tied to a companion weed role for domesticated *C. pepo*? Or are they more generally adapted weeds of the agroecosystem? Do these gourds occur only in human-disturbed habitats, or do they also exist in natural settings, either close to or far removed from gardens and agricultural fields? Obviously, the further removed from agricultural contexts that such gourds grow, the stronger the case for the range extension of a wild gourd. Conversely, the more tightly tethered they are to specific soybean field habitats of the agroecosystem, the stronger the case for an escaped ornamental.

## DOCUMENTING THE HISTORIC TIME DEPTH OF THE WILD *Cucurbita* GOURD IN THE EAST

While the Asches (1992) devote considerable attention to establishing the absolute pre-World War II absence of noncultivated *pepo* gourds in eastern North America, a growing body of archaeobotanical data suggests a wild morphotype *Cucurbita pepo* gourd was present in numerous places in the Southeast and Midwest as early as 12,000 years ago, to as late as 200 years ago.

We have already noted the ancient presence of a morphologically wild cucurbit in eastern North America. This evidence places a thin-walled, brittle-shelled, small seeded *Cucurbita pepo* gourd in Florida by 12,000 B.P. (Newsom et al., this volume), in west-central Illinois by 7000 years ago (Conard et al. 1984), in eastern Tennessee 6990–5300 B.P. (Crites 1991), in south-central Missouri and eastern Kentucky by 4500 years ago (Kay et al. 1980, Cowan 1990), and as late as A.D. 800–1750 in eastern peninsular Florida (Decker and Newsom 1988). As yet undated, but morphologically wild cucurbits have also been recovered from several Ozark rockshelters (e.g., Gilmore 1931, Plate 24a). Unequivocal evidence of domesticated forms, indicated by an increase in rind thickness and seed length, does not seem to occur in the East until sometime after 4000 B.P. (Cowan 1990; Smith 1992).

In addition to the archaeological presence of a wild gourd in Florida for at least 12,000 years, and across the Midwest and Southeast for the past 7000, our herbaria survey produced records of a wild morphotype *Cucurbita pepo* in the St. Louis area between 1846–1901 (Table 1). These collections—housed in the herbaria of the University of Texas, Harvard University, the Illinois State Museum, and the Missouri Botanical Garden—provide dramatic evidence of how botanists have struggled over the past 150 years with the taxonomic puzzle represented by the wild gourd.

Collections from the St. Louis area are especially important. As the gateway to the west in the mid-nineteenth century, and the largest city between the Mississippi and the Pacific, St. Louis was a center of science and culture. It was also the staging area for every important scientific exploration of the western territories, and was in every sense of the word, on the edge of civilization.

Perhaps because of its strategic location, St. Louis was also a center of scientific botany in the nineteenth century. The Missouri Botanical Garden, founded in 1859, was the focus of much early botanical research, and contains significant collections that have a direct bearing on the history of *Cucurbita* evolution in the East. Three of the earliest collections of an eastern *Cucurbita pepo* gourd are curated

at the Garden. All were deposited by George Engelmann, a St. Louis physician, amateur botanist, and the Garden's long-time chief curator. Engelmann published dozens of articles dealing with botany and was considered an authority on several genera. Today, his botanical notes occupy 60 "large books," which are part of the Garden's collections (Spaulding 1909:128). Engelmann focused a great deal of attention collecting plants in St. Clair county, Illinois in that portion of the Mississippi River floodplain known as the American Bottom (Yatskievych, personal communication, August, 1990).

Engelmann's pressed *Cucurbita* specimens include two grown in St. Louis from seeds collected in Texas. One (MO-3265655) was identified by Engelmann as "*Cucurbita ovifera* Lin. var. *pyriformis,*" and was collected in September, 1846 from a French plant collector, Nicholas Riehl (the specimen label reads "Cult. from Texas seeds by N. Riehl, St. Louis"). A specimen collected in July, 1848 (MO-3265676) is simply identified as "*Cucurbita*" and carries the inscription "From Texas seeds cult. in St. Louis." The third specimen (MO-3265373) is perhaps the most significant. Labelled only "*Cucurbita*" with the note "Naturalized, St. Louis along fences and fields," this specimen was collected in September, 1846, the same year and month Engelmann collected MO-3265655—the plant grown from seeds identified as "*Cucurbita ovifera* var. *pyriformis.*" The fact that he did not identify the "naturalized" plant to species level, and chose not to designate it as *C. ovifera* var. *pyriformis,* perhaps indicates his caution regarding the taxonomic placement and wild versus cultivated status of the plant.

If Englemann's "naturalized" specimen was the sole record of a potentially wild *Cucurbita pepo* gourd growing in St. Louis it would be reasonable to consider it a likely "escape." However, there also exist eight other collections of potentially wild *Cucurbita* gourds from St. Clair County, Illinois made between 1875 and 1893. Five of these were made by Heinrich (Henry) Eggert, an amateur botanist who moved to St. Louis in 1874, and resided in the American Bottom in East St. Louis until his death in 1904, at which time his personal herbarium of more than 23,000 specimens was purchased by the Missouri Botanical Garden. During his active career Eggert ". . . collected assiduously all around St. Louis for a considerable distance, and his collection probably represented the flora of this district better than any other ever made" (Spaulding 1909:252).

Although considered an expert on the flora of the St. Louis area, Eggert published only one brief 16-page pamphlet. His *Catalogue of the Phaenogamous and Vascular Cryptogamous Plants of the Vicinity of St. Louis, Missouri,* published in 1891, however, has a particularly interesting entry. Eggert lists nearly 1,100 plants as being indigenous to the area, and as late as 1909 his inventory was considered "by far the most complete list of our plants which has yet appeared" (Spaulding 1909:252). Among the plants he lists as native is *Cucurbita ovifera* var. *pyriformis.*

Eggert's labels from his "Herbarium Americanum" contain few specific locality data, but labels for three of the five specimens of *Cucurbita* gourds do list habitat information. These include: "lowland" (MO-768398), "waste places" (MO-3265660), and "prairies and waste places" (Harvard-Eggert s.n.).

Eggert identified three specimens as "*C. ovifera* var. *pyriformis*" (MO-768398, TX-Eggert s.n., Harvard-Eggert s.n.), one as "*C. ovalis*" (MO-739055), and one as "*Cucumis*" (MO-3265660). The remaining specimens were simply identified as "*Cucurbita.*"

Two specimens—one collected in July, 1875 (MO-768398) and another in August, 1893 (Harvard-Eggert s.n.)—contain small (< 8 cm in length), pyriform, green-striped fruits. In terms of fruit and seed size, both appear strikingly similar to the wild morphotype gourds collected during the present study (see below).

In addition to these nineteenth century collections, at least one specimen was collected in the American Bottom just after the turn of the century (MO-883257). This specimen, originally labelled "*C. ovifera,*" was collected by John Kellogg in woods adjacent to Fish Lake in October, 1901. Fish Lake is a large cut-off meander lake in the American Bottom.

Annotations of these early collections made by subsequent scholars provide some indication of the broader taxonomic caution that has obscured the possibility of a wild *Cucurbita pepo* gourd being present in the East. Interestingly, L.H. Bailey examined the Eggert specimen ("*C. pepo* var. *pyriformis*" housed in the University of Texas Herbarium and proclaimed it to be *C. texana*. Taxonomic reassessments of the Missouri Botanical Garden specimens were recently examined and annotated by Thomas C. Andres of the L.H. Bailey Hortorium between 1989–1990.

It is often difficult to distinguish between the different domesticated and wild forms of *C. pepo* based solely on herbarium specimens, where only a small portion of the plant might be present. As a consequence, contextual information supplied on the label is often considered, as is the identity of the collector. Plants collected in the railroad yards of St. Louis and identified as "escapes" by Hugh Cutler, a noted cucurbit researcher, were accepted by Andres, for example.

Applying current nomenclature, Andres annotated Engelmann's specimens grown from Texas seed and originally labelled *C. pepo* var. *pyriformis*, as *Cucurbita texana*. The specimen Engelmann described as "*naturalized* along fence rows and waste places" (emphasis added) and identified as *Cucurbita*, was assigned to *C. pepo* by Andres. This is particularly interesting when the specimens collected by Eggert from the same area a few years later are considered. Sometime after the Garden acquired Eggert's collection, the specimen he identified as "*Cucumis*" and listed as growing in "waste places in East Carondolet," was re-identified by an unknown researcher as a domesticated ornamental gourd ("*C. pepo* var. *ovifera*"). This same specimen was *re-identified* in 1989 by Andres as "*C. pepo* ssp. *texana*."

In spite of the fact that the remaining nineteenth century *Cucurbita* specimens in the Missouri Botanical Garden all bear habitat descriptions indicating collection outside of contexts of cultivation (i.e., "waste places," "fence rows," "low ground," "prairies"), and one contains a mature fruit that falls within the wild morphotype, Andres was sufficiently hesitant regarding their taxonomic status to identify each only as *C. pepo*.

We would argue that earlier recognition of an indigenous eastern North American *Cucurbita pepo* gourd has been hindered by the absence of an appropriate taxonomic category and label. Engelmann and Eggert employed the taxonomic label "*C. pepo* var. *pyriformis*" based on the pear-shaped fruit to refer both to plants grown from Texas seeds and plants found growing outside of cultivation in St. Louis. Subsequent annotation of these specimens has either assigned them to the Texas wild gourd (*C. pepo* var. *ovifera* ssp. *texana*), or more cautiously, *C. pepo*. We propose a different reading of this early herbarium evidence.

By 1846 (11 years after its discovery in Texas), botanists in the St. Louis area

were collecting a seemingly wild morphotype gourd indistinguishable from *C. pepo* ssp. *ovifera* var. *texana,* and later Eggert included it as a member of the local flora. Similar collections were made throughout the remainder of the nineteenth and first few years of the twentieth centuries. Rather than simply representing "escapes" from local gardens we believe these early specimens were of an indigenous, wild *C. pepo* gourd.

Our herbaria survey, along with archaeologically recovered gourds, provide strong support for the long-term presence of an indigenous wild gourd in eastern North America long before modern field agriculture. These data provide the first link in our argument countering the position that the weedy infestations of gourd in floodplain fields in the East represents a post-World War II escape into a narrow agricultural weed niche. An examination of the availability of cultivated forms of *Cucurbita pepo* ssp. *ovifera* to eastern North American gardeners provides another.

## HISTORY OF THE AVAILABILITY OF ORNAMENTAL GOURDS TO GARDENERS IN EASTERN NORTH AMERICA

A recent examination of more than 500 pre-1870 seed catalogues in the National Agricultural and National Horticultural Libraries provides a solid baseline against which the availability of ornamental gourds (*C. pepo* ssp. *ovifera*) to the American gardener can be measured. Descriptions of ornamental gourds in these catalogues also help establish both the context of their recommended cultivation as well as a time horizon for any supposed "escape" that might have occurred.

While William Bartram circulated hand-written lists of seeds and plants available for distribution in the late eighteenth century, seed catalogues did not become widely available until after the Civil War. They proliferated as the nineteenth century came to a close. The earliest printed catalogue we examined is Bernard M'Mahon's *Catalogue of American Seeds,* dated 1804.[2] In it are listed four cucurbits: *C. pepo, C. verucosa, C. melopepo,* and *C. ovifera* (M'Mahon 1804:20). *C. ovifera* is listed as the "egg-shaped gourd." Significantly, no other fancy gourds are offered. There is no further mention of the "egg" gourd in seed catalogues until the mid-1860s. In the interim, numerous almanacs and catalogues advertised ornamental gourds. They are touted as early as 1819 (M'Mahon 1819:369) as useful for covering arbors, trellises, walls, and fences. Two varieties are invariably offered in the earliest catalogues: "bi-colored," and "orange" (cf. William Prince and Sons 1834-35:19; Hovey and Co. 1845:6; B.K. Bliss 1860:19).

By the end of the Civil War, the number of ornamental gourd varieties listed in catalogues increased dramatically. Both Vick's *Illustrated Guide and Floral Catalogue for 1866,* as well Hiram Sibley's *Garden, Field and Flower Seed Catalogue for 1879,* for example, list seven *Cucurbita pepo* gourds. James Vick's *Fifth Annual Catalogue of Seeds* (1866) is especially significant. In addition to offering a variety of fancy gourds, he offered a gourd described as "Egg-formed, like the fruit of White Egg plant, very beautiful and *new*" (Vick 1866:43, emphasis added). A nearly identical description is found in M. O'Keefe and Sons catalogue for 1868 (pg. 29). By 1871, companies in Illinois, Ohio, and New York were offering the egg gourd, along with other varieties, almost always listing them as mainly useful for their climbing ability and for covering trellises and arbors.

While the "egg" variety is listed in many catalogues in these decades—often with the description "like the fruit of a white egg plant"—in the 1880s several catalogues began providing a separate, lengthy description for this ornamental. Burpee's *Farm Annual* for 1883 is typical of this new status. Listed as the "White Egg-Formed Gourd" (1883:18) it is also called the "Japanese Nest-Egg Gourd." The fruits are illustrated and described as:

> . . . they exactly resemble, in color, size, and shape the eggs of hens, and do not crack, and are uninjured by the by cold or wet, they make the very best nest eggs

Although hardly used today, before the advent of electronic incubation artificial "nest eggs" were often placed in a nest to encourage the hen to lay more eggs and remain on the nest until they hatched. Glass eggs were typically used by those who could afford them. The egg gourd seems to have been marketed as an inexpensive alternative.

Nest egg gourds continued to be advertised in late nineteenth and early twentieth century catalogues. As commercial poultry hatcheries developed, however, their status began to change. The D.M. Ferry & Company (later the Ferry-Morse Seed Company), provides a good example of the evolution of this transformation. During the first three decades of this century, Ferry lists and illustrates no less than six ssp. *ovifera* gourds, including the "Japanese nest egg." By 1933, however, these distinct varieties began to be subsumed under the single heading "mixed" gourds. While continuing to tout the general utility of all forms of gourds for covering trellises and arbors, in the 1937 catalogue (p. 57), the "small fruited mixed" listing suggests that these are of "An assortment of interesting shapes suitable for table decoration and other ornamental purposes." This is the use for ssp. *ovifera* cultivars today, and marks the first time this specified usage appears in seed catalogues.

To summarize, our examination of seed catalogues suggests that ornamental gourds have a lengthy history in North America. While the egg gourd was advertised as early as 1804, it did not become intensively marketed until the 1880s. Throughout the period 1800–1880, the egg gourd was only one of a number of gourds advertised for sale. Of these, the bi-color, and orange ball are the most frequently mentioned ornamentals until about 1870. After 1870, there is a dramatic increase in the number of *Cucurbita pepo* gourd types offered.

Before the 1880s, ornamental gourds were generally marketed for their ability to cover trellises and arbors. There is no indication they were marketed for any other use. This places the context of their cultivation in areas immediately adjacent to the home with no evidence that they were cultivated commercially. During the 1880s, the so-called egg gourd was often described separately from other ornamental gourds. While still advertised as an ornamental, this particular variety was marketed primarily as an egg mimic. As home production of eggs waned, the egg gourd fell out of favor. By the 1930s *pepo* gourd cultivars were advertised for their usefulness as ornaments.

How does this review strengthen or weaken the "recent escape" hypothesis advanced by the Asches and others? Ornamental *Cucurbita pepo* gourds have been commercially available for nearly 200 years; seven different varieties have been marketed since the 1870s. Clearly, there have been opportunities for all to "escape"

into the wild. In spite of this, however, only two fruit types predominate in the free-ranging populations of the Southeast and Midwest (see below). The so-called egg gourd is the more common, though a green and white striped form also occurs. If these free-ranging populations represent escapes, why didn't other varieties do the same? Why don't warty, crown of thorns, orange, bi-color, and spoon varieties also occur outside of cultivation? Our seed catalogue survey suggests these more showy varieties were available longer and were aggressively marketed through the first half of the nineteenth century. We believe the absence of these fancy gourds in natural settings is significant evidence arguing against the possibility that *Cucurbita pepo* gourds frequently "escape" from cultivation. Examining the niche and preferred habitat of free-ranging egg and green-striped gourds provides further evidence relative to this issue.

## THE NICHE AND HABITAT OF FREE-RANGING GOURDS

Few detailed descriptions of the niche and habitat of *Cucurbita pepo* ssp. *ovifera* var. *texana* and related free-living populations are available. Most habitat information regarding these plants consists of brief field observations, often in the form of locational descriptions on herbarium sheets. To augment these records, we studied gourd populations in the field. The following observations are based upon studies of free-ranging gourd populations in the Missouri and Arkansas Ozarks in November, 1990, and in Western Kentucky during November, 1991.

Efforts were concentrated in the Missouri and Arkansas Ozarks since (1) this area was noted by Steyermark (1963) as containing county records of a free-ranging cucurbit; (2) a large portion of the Ozark Plateau is densely wooded and sparsely populated; and (3) a number of river headwaters are located in the Ozarks, and if cucurbits were located in their upper reaches, they might be found in more distant, downstream areas.

Studies in western Kentucky were concentrated in Union County, in the Ohio River floodplain several miles below the confluence of the Ohio and Wabash rivers. Union County was chosen because of the senior author's strong consanguineal ties and familiarity with the area. Cowan was afforded access to property and local informants that proved invaluable in the search for free-ranging gourds.

*The Ozarks*.—Collections were made along the Gasconade River in Missouri and the White and Buffalo Rivers in Arkansas. In addition, collections made by Hoffman and students in the western Ozarks were studied. Descriptions of these collections have been documented elsewhere (Smith et al. 1992). The Buffalo River populations, however, provide a typical example of the types of habitats free-ranging *Cucurbita pepo* gourds occupy, and an opportunity to measure their success outside modern agroecosystems.

There are few areas in eastern North America that compare with the Buffalo River in terms of assessing the ability of free-living *pepo* gourds to exist in natural floodplain settings far removed from agricultural habitats. The Buffalo River valley, and the Ozarks in general, also represent an excellent potential heartland and refuge area where a wild indigenous gourd could have grown in relative obscurity until Steyermark collected it in the 1950s.

For the past 20 years the entire main valley corridor of the Buffalo river (388 square kilometers) has been almost free of human habitation, much less agricultural fields. While there are small family farms along the tributaries of the Buffalo River today, the river's watershed of 555 square kilometers is heavily forested and remains one of the least populated regions in Arkansas, with Newton County averaging 18 persons per square kilometer (Pitcaithley 1987:89). The history of human occupation of the Buffalo River valley has been well documented (Pithcaithley 1987), and provides a picture of sparse population and limited agricultural development. The area did not witness a post-World War II boom in soybean cultivation, and throughout its history would have provided few opportunities for survival of a narrow agricultural niche *pepo* weed. Because of its relative isolation and limited human occupation, the Buffalo River valley does, on the other hand, provide an opportunity to establish the presence (perhaps long-term) of populations of an indigenous wild gourd far removed from agricultural settings.

The Buffalo River valley also provides an opportunity to consider the general habitat requirements of the free-living *Cucurbita pepo* gourd. The town of Pruitt marks a transition point for the river as it widens from a narrow rocky valley floor with swiftly flowing water into a broader floodplain having reduced water velocity and a meandering channel with associated sand and gravel bank, bar, and island formations. Extensive survey above Pruitt yielded no evidence of the plant, while populations were common on the sand and gravel bars, banks, and islands in the areas surveyed below the Nars (Fig. 2). Gourd populations were noted in diverse settings within these general habitats. Typically, plants were rooted on the floor of lightly shaded riparian forests dominated by sycamores, maples, and willows. Vines climbed as much as 3–4m into the overstory trees, or grew laterally towards less shaded areas where they assumed a procumbent habit or overtook herbaceous annuals such as ragweed and cockleburr.

The populations encountered in the Ozarks also provided information on dispersal mechanisms for free-living *Cucurbita pepo* gourds. No evidence of predation of gourds by birds, mammals, or insects was observed in our survey, suggesting dispersal was largely, but not completely, accomplished by other means. Ample evidence of dispersal of dried, buoyant gourds by spring and winter floodwaters, however, was noted. All phases of the floating gourd dispersal process were observed along each of the Ozark stream and river courses we surveyed. We observed gourds resting well within the reach of spring floodwaters. In at least one location last year's gourd crop was also observed in transit, floating within an abandoned navigational lock chamber at Batesville, Arkansas. We also saw gourds in a wide variety of locations where they had been carried by floodwaters, such as caught against bushes or other floodwater "filters," trapped inside hollow stumps, lying on the ground where they were left by receding floodwaters, deposited along roadside ditches and bridge approaches adjacent to river and stream valleys, and frequently in piles of wood and other debris deposited by powerful floods.

This last depositional context, which often places the gourds in juxtaposition with objects discarded by humans, is likely the source of occasional observations that this plant grows in "dumps" and "waste places," and the conclusion that it therefore likely represents an escape from cultivation. The river or stream valley

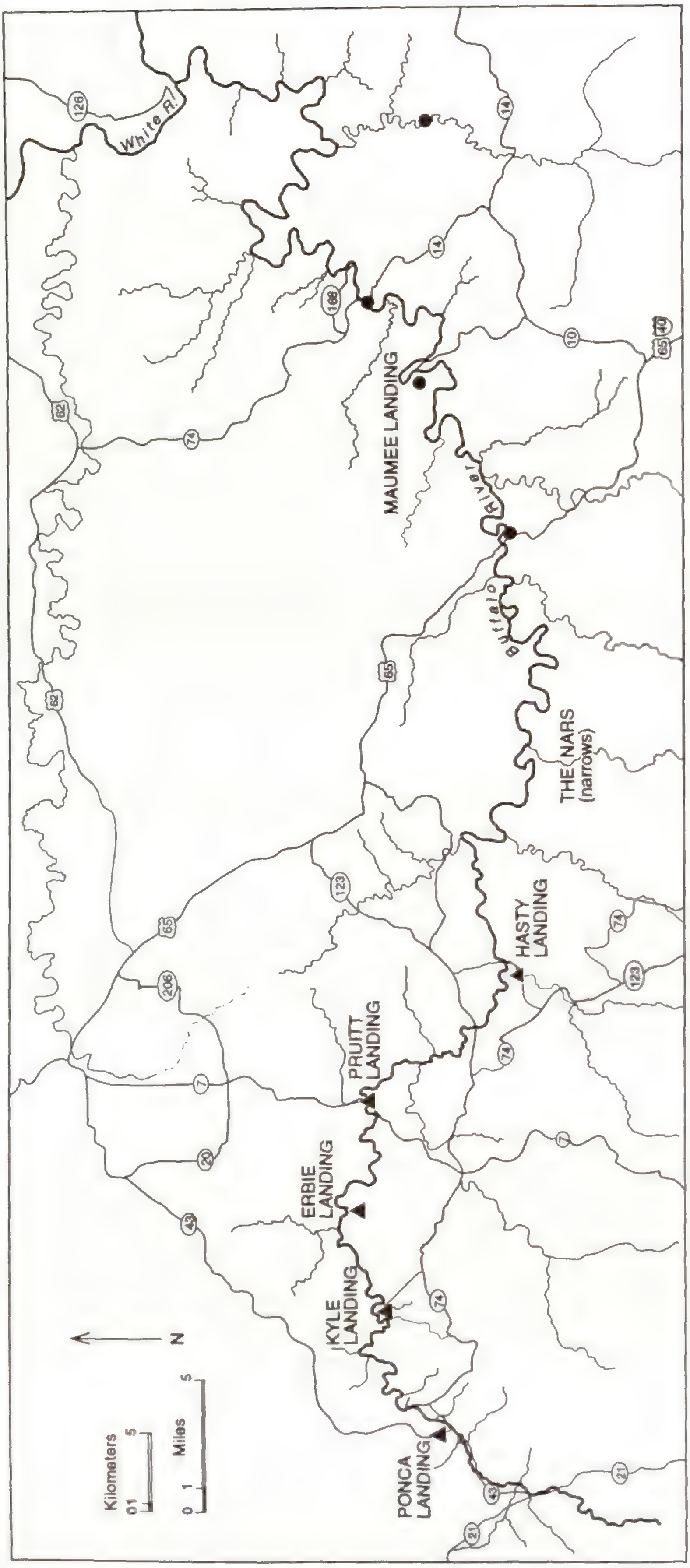


FIG. 2.—Collection localities along the Buffalo River. Triangles indicate localities where wild gourds did not exist in November, 1991; circles localities where wild gourds were collected.

location and taphonomic context of such deposits identifies them as an inherent component of floodplain environments, rather than directly resulting from human disposal activities. Bringing the process of seed dispersal full circle, vines of plants in a number of locations originated in the fragmented remains of dry brown gourds deposited by floodwaters of the previous spring.

*Western Kentucky.*—In Union and Henderson Counties, Kentucky, free-living *Cucurbita* populations, known as "Johnny Gourds," have been growing for years. Most farmers indicated they have always been present in the floodplain of the Ohio River, but have become a much greater problem with the draining and opening up of formerly forested floodplain areas.

Typically, "Johnny Gourds" emerge in the spring from the forest lining the bank of the Ohio, or from drainage ditches far removed from the river. As the growing season progresses, the vines aggressively invade fields where, unless controlled, they overtake corn and soybean crops. They can be checked by pre-emergent and broadleaf herbicides, but are virtually impossible to eradicate. Collections made near DeKoven, Kentucky, provide a good example of this problem: a drainage ditch had been sprayed at least twice but we collected dozens of gourds from both the bottom of the ditch and the field margin.

This cultivated field habitat is far different than that we encountered during our Ozark survey, and accounts for the origin of the "recent escape" hypothesis. In addition, all Union County fruits showed evidence of introgression with other cultivars. Both the Asches (1992) and Wilson (1990) made similar observations about collections from a modern agroecosystem on Kaskaskia Island, Illinois. On the other hand, local informants suggest that while "Johnny Gourd" populations have become more abundant in the past 30 to 40 years, they have been present far longer. The fact that these western Kentucky populations exhibit extensive introgression with cultivar *pepo* varieties is the logical outcome of their frequent exposure to garden crops along the populated Ohio River.

## MORPHOLOGICAL CHARACTERISTICS OF MODERN *Cucurbita* GOURDS AND THEIR RELATIONSHIP TO ARCHAEOLOGICAL CUCURBITS

The combined information from our herbaria survey and field observations provides strong support for the argument that contemporary eastern *Cucurbita pepo* gourds are not simply "escapes" from cultivation or recently introduced agricultural weeds, but are rather part of an indigenous flora. Viewed in this light, the wild gourds are the closest, and most logical ancestors for the eastern lineage of *C. pepo* isolated by Decker in her isozyme studies (see Decker-Walters et al., this volume). If these contemporary gourds represent the basal stock from which other cultivars of *C. pepo* ssp. *ovifera* evolved, it is important to examine the metric characteristics of these populations, and compare them with their cultivated counterparts and collections from pre-4000 B.P. contexts in eastern North America.

Morphological information related to this issue was collected from the following sources: (1) a sample of wild morphotype fruits collected from the Ozarks in 1990, (2) a sample of cultivated varieties of *C. pepo* ssp. *ovifera* grown in a field

setting in Hamilton County, Ohio in 1991, and (3) samples of cultivated and wild *Cucurbita* populations reported by Decker and Wilson (1986). Metric information from archaeological samples at Hontoon Island, Florida was provided by Lee Newsom of the Florida Museum of Natural History, while that from Phillips Spring, Missouri was provided by Smith.

The following discussion is based upon measurements of 15 fruits collected during our Ozark survey, each from an individual plant. Fruit size, rind thickness at various points, peduncle diameter (when available), and seed length and width were measured (Fig. 3, Table 2–3). Statistical information from other contemporary and archaeological *Cucurbita* populations are listed Tables 4–5.

*Fruit size, shape, and color.*—Fruits from our Ozark sample are small and exhibit a limited number of shapes (Fig. 4). Maximum height ranges from 3.9–10.0 cm (mean 5.9 cm) (Table 2). Maximum fruit diameter is less variable than height and averages 4.6 cm (range 3.2–5.5 cm). Fruit shape varies from nearly circular, to oblate, to pear-shaped with most assuming a slightly prolate form (Fig. 4). This geometry can be expressed as a ratio which incorporates both maximum fruit height and maximum fruit diameter where *Fshape* = *maxht/maxdia*. In this expression, *Fshape* is a measurement of the circularity of the fruit; in a circular fruit this ratio is one. The closer the ratio is to one, the more globular the fruit. As can be seen in Fig. 5, this objective classification yields results which confirm our subjective observations: most fruits are slightly prolate. The two specimens greatly exceeding one are classified as pear-shaped.

Two distinct fruit colors were noted in the Ozark sample. By far the majority were ivory; immature fruits of this type were pale green. A small number of fruits were pale green to ivory with dark green stripes. When stripes occurred, they were invariably 10 in number. Striped and unstriped fruits were never noted growing on the same plant, although plants producing the two fruit colors were found on the same sand or gravel bar.

The epidermis of the fruits was almost always smooth and unlobed. Although a few fruits did possess minor epidermal warts, these were infrequent, and seemed to have developed as the result of some injury to the fruit wall as it was maturing. The lack of wartiness and lobing is significant for it suggests these gourds have not experienced extensive introgression with cultivars. We specifically noted a lack of introgression with two common edible cultivars—the yellow crookneck and the acorn squash. Crookneck cultivars are often strongly warty and yellow in color; acorn cultivars are invariably strongly lobed and dark green. Warty ornamentals of the yellow-flowered gourd (*C. pepo* ssp. *ovifera*) might also be expected to be grown in the Ozarks, but no evidence of their contaminating presence was noted in our collections. In the two instances of introgression we did note, fruit shape and coloration suggest hybridization with other *Cucurbita* cultivars. One of these, collected from a driftwood pile on the Gasconade River in Wright County, Missouri, seems suggestive of crossing with butternut (*C. moschata*); genetic analysis (Deena Decker-Walters, personal communication, 1992; see Smith et al. 1992, Fig. 4.12) supports this. In addition, two fruits were collected from a plant in the White River valley of Searcy county, Arkansas, that were yellow-orange with pale yellow stripes.

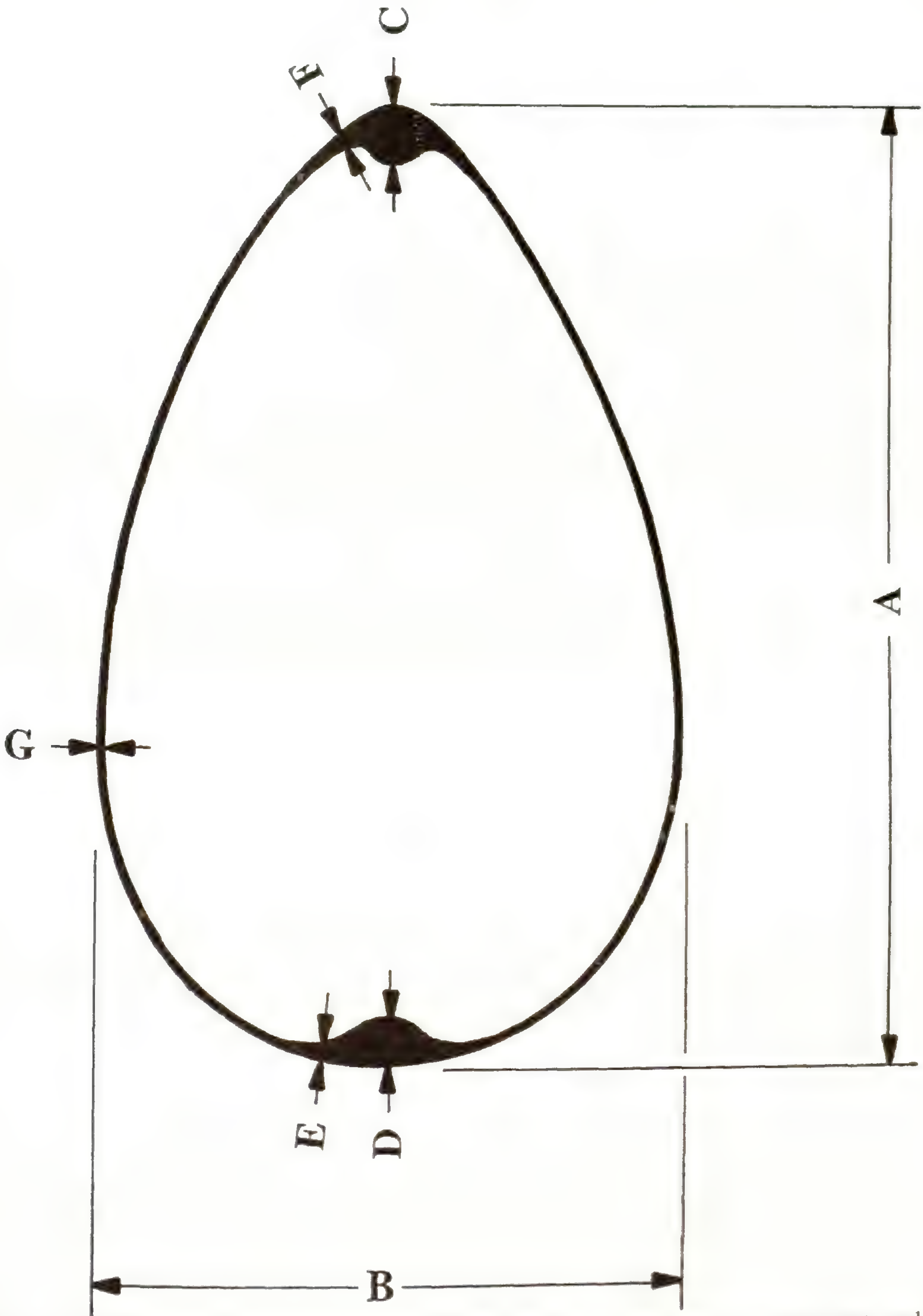


FIG. 3.—Schematic cross-section of a *Cucurbita* fruit showing measurements collected. A: maximum fruit height; B: maximum fruit diameter; C: peduncle "knob" thickness; D: corolla, or blossom, "knob" thickness; E: thickness adjacent to corolla "knob"; F: thickness adjacent to peduncle "knob"; G: thickness at maximum fruit diameter.

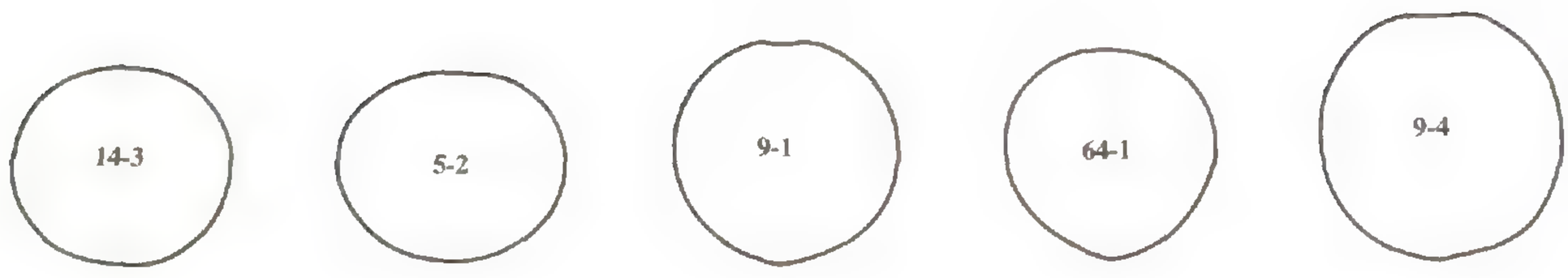


FIG. 4.—Fruit shapes for selected Ozark cucurbit fruits. Numbers correspond to field specimens.

TABLE 2.—Measurements of fruit size, shape, and rind thicknesses for selected Ozark cucurbits.

| Field/ Lab No.[1] | Max Hght[2] | Max Dia | Fshape | Thk 1 | Thk 2 | Thk 3 | Ped Thk | Blos Thk |
|---|---|---|---|---|---|---|---|---|
| 3-1 | 6.1 | 5.1 | 1.19 | 1.6 | 1.3 | 1.5 | 4.9 | 4.9 |
| 4-1 | 8.3 | 4.7 | 1.76 | 1.8 | 1.5 | 1.9 | 3.8 | 4.4 |
| 5-1 | 4.0 | 5.2 | 0.76 | 0.9 | 0.8 | 0.9 | 4.0 | 3.7 |
| 9-2 | 5.2 | 4.6 | 1.13 | 2.0 | 1.1 | 1.4 | 5.6 | 3.2 |
| 9-4 | 5.3 | 5.3 | 1.00 | 2.0 | 2.0 | 2.0 | 5.8 | 6.0 |
| 11-1 | 4.2 | 4.0 | 1.05 | 1.4 | 1.1 | 1.2 | 4.9 | 5.0 |
| 14-1 | 6.0 | 5.0 | 1.20 | 1.6 | 1.4 | 1.9 | 4.7 | 4.4 |
| 14-3 | 4.3 | 4.9 | 0.87 | 1.6 | 1.2 | 1.6 | 5.1 | 3.2 |
| 14-5 | 5.3 | 4.1 | 1.29 | 1.9 | 1.2 | 1.9 | 4.7 | 4.6 |
| 14-6 | 6.1 | 4.7 | 1.29 | 1.9 | 1.2 | 2.2 | 4.5 | 6.2 |
| 14-9 | 3.9 | 3.2 | 1.21 | 2.0 | 1.1 | 1.4 | 5.6 | 3.2 |
| 14-10 | 8.4 | 5.2 | 1.61 | 1.5 | 1.0 | 1.3 | 3.5 | 6.2 |
| 14-11 | 5.7 | 4.5 | 1.26 | 1.8 | 1.9 | 1.9 | 7.7 | 6.0 |
| 64-2 | 6.1 | 5.5 | 1.10 | 1.5 | 1.0 | 1.4 | 5.0 | 4.8 |
| 65-1 | 10.0 | 4.4 | 2.27 | 1.5 | 1.3 | 1.3 | 4.8 | 3.8 |

[1]Key to Field/Lab No: 3-1 Wilbur Allen Wildlife Refuge, Wright County, Missouri; 4-1 Hodgson Mill, Ozark County, Missouri; 5-1 Batesville, Independence County, Arkansas; 9-2, 4 Highway 9 Bridge, Woodruff County, Arkansas; 11-1 Manes, Wright County, Missouri; 14-1,3,5,6,9,10,11 Highway 14 Bridge, Searcy County, Arkansas; 64-2 Highway 64 Bridge, Woodruff County, Arkansas; 65-1 Highway 65 Bridge, Searcy County, Arkansas.

[2]See Figure 3 for these measurements. MaxHght = maximum height; MaxDia = maximum diameter; Fshape = fruit shape (MaxHght/MaxDia); Thk1–3 = rind thickness 1–3; PedThk = peduncle thickness; BlosThk = Thickness of rind at blossom. All measurements in cm.

*Rind thickness*.—It has been argued that rind thickness is an important factor in determining when cultivar squash first appeared in gardens in eastern North America. Smith (1987) argues that archaeological squash rind less than 2 mm in maximum thickness and dating before 3000 B.P. can not be used as evidence for domesticated forms, since rind of this thickness falls within the size range of wild morphotype gourds. Our Ozark collections provide additional information on this point.

Rind thickness was measured in five areas on each of fifteen fruits (Fig. 3, Table 2). Rinds of all fruits were thicker at the peduncle and blossom (corolla) ends, where a corky "knob" often forms in the fruit cavity. Thickness of these internal "knobs" ranges from a mean of 4.9 mm (range 3.5–7.7 mm) at the peduncle end to 4.6 mm (range 3.2–6.2 mm) at the blossom end. With the exception of these two areas, rind thickness elsewhere exceeded 2 mm in only one of the fruits measured (Table 2). Rind is thinnest at the point of greatest maximum deflection. Variability in thickness, as expressed by the coefficient of variation (CV) (Simpson et al. 1960), is quite low, suggesting that this morphological characteristic is conservative, and the Ozark population fairly homogeneous (Table 2).

Rind thickness in cultivated forms of *Cucurbita pepo* squash in contrast, *can* be

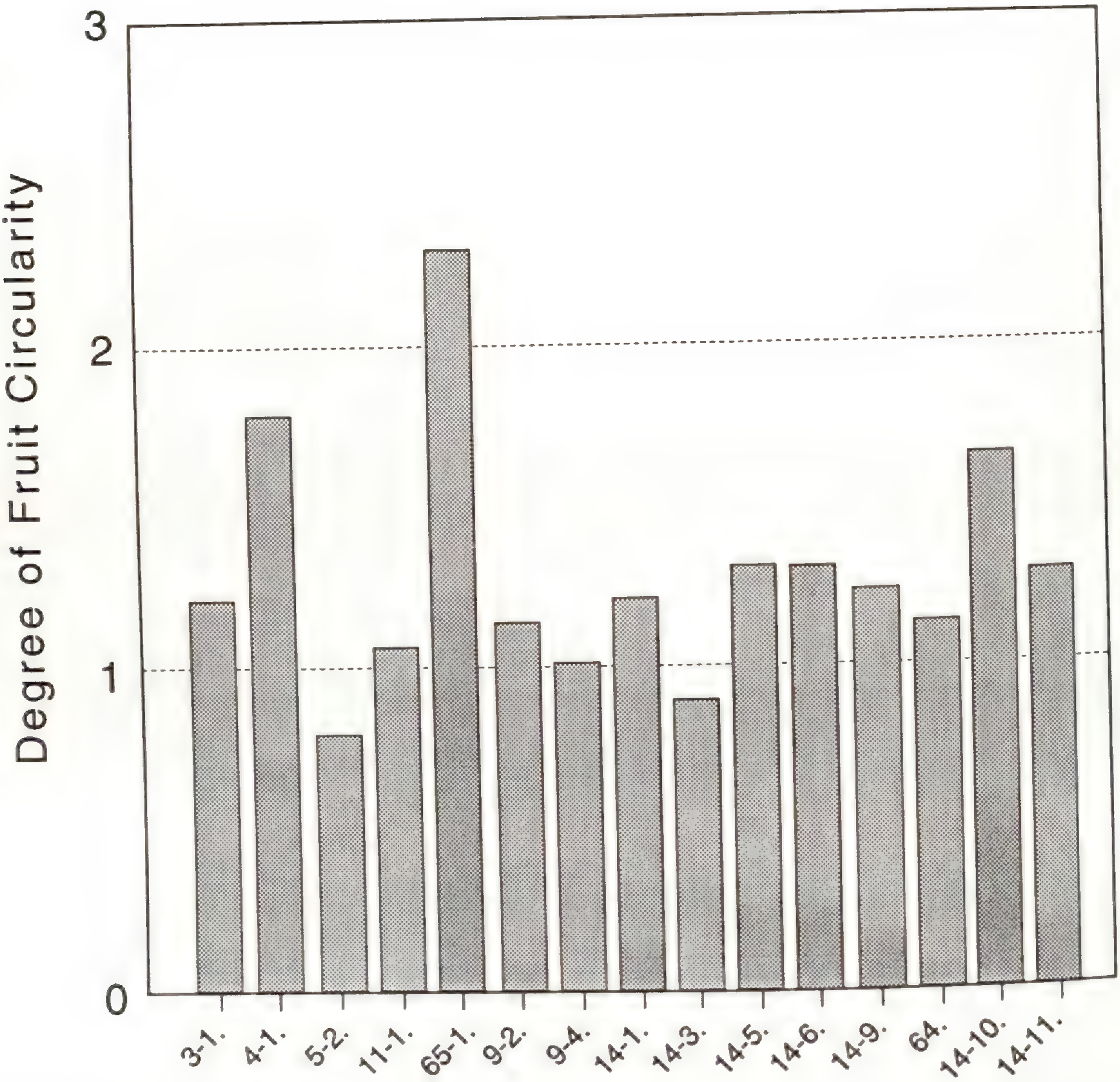


FIG. 5.—Bar graph of Ozark fruit shapes. Note the number of fruits falling close to 1, indicating a relatively circular shape. Spikes indicate pear-shaped fruits.

quite variable. Differences in rind thickness among pumpkins, acorns, and crooknecks seems to be related to variation in wall thickness associated with lobing and wartiness. Since gourd-like forms invariably have a non-textured epidermis, rind thickness is fairly uniform from one place on the fruit to the next.

Based upon these observations, we believe it is possible to use the 2 mm rind thickness cutoff for identifying clearly domesticated archaeological *Cucurbita* in the East. Once domestication occurs, there is an initial trend towards increasing rind thickness, which is accompanied by variability in epidermal characters, including lobing and wartiness (Cowan 1990). The well-preserved pre-4000 B.P. rind fragments from Cloudsplitter and Phillips Spring less than 2 mm thick are smooth textured, with no evidence of lobing or wartiness, suggesting that they are not the domesticated form.

TABLE 3.—Measurements for Ozark gourd seeds.

| Field/No.[1] | Mean Lngth[2] | Range | Std. Dev. | Mean Wdth | Range | Std. Dev. |
|---|---|---|---|---|---|---|
| 3-1 | 9.8 | 9.0–10.6 | .43 | 6.4 | 6.0–6.9 | .26 |
| 4-1 | 9.1 | 7.9– 9.6 | .52 | 5.8 | 4.9–5.8 | .43 |
| 5-2 | 9.3 | 8.6–10.0 | .41 | 6.0 | 5.7–6.4 | .20 |
| 9-2 | 9.0 | 8.3– 9.4 | .34 | 5.7 | 5.3–6.0 | .19 |
| 9-4 | 9.2 | 9.0– 9.9 | .23 | 5.9 | 5.6–6.3 | .19 |
| 11-1 | 9.4 | 8.9– 9.9 | .29 | 6.7 | 6.6–7.0 | .14 |
| 14-1 | 9.1 | 7.7– 9.8 | .45 | 5.9 | 5.3–6.5 | .27 |
| 14-3 | 9.4 | 8.7–10.2 | .41 | 6.1 | 5.8–6.4 | .17 |
| 14-5 | 9.5 | 8.2–10.2 | .49 | 6.4 | 6.0–7.1 | .37 |
| 14-6 | 8.2 | 7.6– 8.6 | .24 | 4.9 | 4.7–5.2 | .13 |
| 14-9 | 7.8 | 7.0– 8.3 | .34 | 5.2 | 4.8–5.7 | .24 |
| 14-10 | 9.2 | 8.5– 9.5 | .25 | 5.7 | 5.5–6.0 | .14 |
| 14-11 | 8.7 | 8.3– 9.0 | .21 | 5.6 | 5.2–6.0 | .20 |
| 64-2 | 10.1 | 9.5–10.9 | .40 | 6.5 | 6.2–7.0 | .18 |
| 65-1 | 9.2 | 8.2– 9.9 | .46 | 5.9 | 5.6–6.3 | .18 |
| Sample Mean | 9.2 | Sample Mean | | 5.9 | | |

[1]See Table 2 for key to field numbers.

[2]MeanLngth = mean length; Std.Dev. = standard deviation; MeanWdth = mean width. All measurements in mm.

The 2 mm maximum thickness baseline we suggest as a useful marker for clearly domesticated forms works best when sample size is fairly large. A rind fragment greater than 2 mm can probably be safely assigned domesticated status, unless it comes from the blossom or peduncle portion of the fruit. However, it is important to keep in mind that thin walled rind fragments (<2 mm thick), might possibly represent domesticated fruits. In other words, while rinds thicker than 2 mm are good markers for domesticates, rinds thinner than 2 mm do not prove wild status. In the latter case domestication simply cannot be established.

*Seed size and characteristics.*—A sample of 20 seeds was selected from each fruit and seed length and width measured (Table 3). Mean length of seeds was 9.2 mm (range 7.8–10.1 mm); mean width 5.9 mm (range 4.9–6.7 mm). The coefficients of variation were quite low, suggesting a fair degree of conservatism in seed size within the population. Not surprisingly there is a positive relationship between seed length and width ($r = 0.85$). Seed size (measured by length × width), however, appears unrelated to fruit size (measured by height × diameter) (Fig. 6).

Comparing seed size of the Ozark fruits with archaeological specimens from pre-4000 B.P. (Cloudsplitter, Kentucky and Phillips Spring, Missouri) and late prehistoric (Hontoon Island, Florida) contexts, the Texas gourd, and contemporary commercial ornamental gourds (Decker 1986), produces interesting results (Table 4, Fig. 7). When archaeological samples are compared with recent collections, two factors stand out. First, there is considerable overlap in the standard

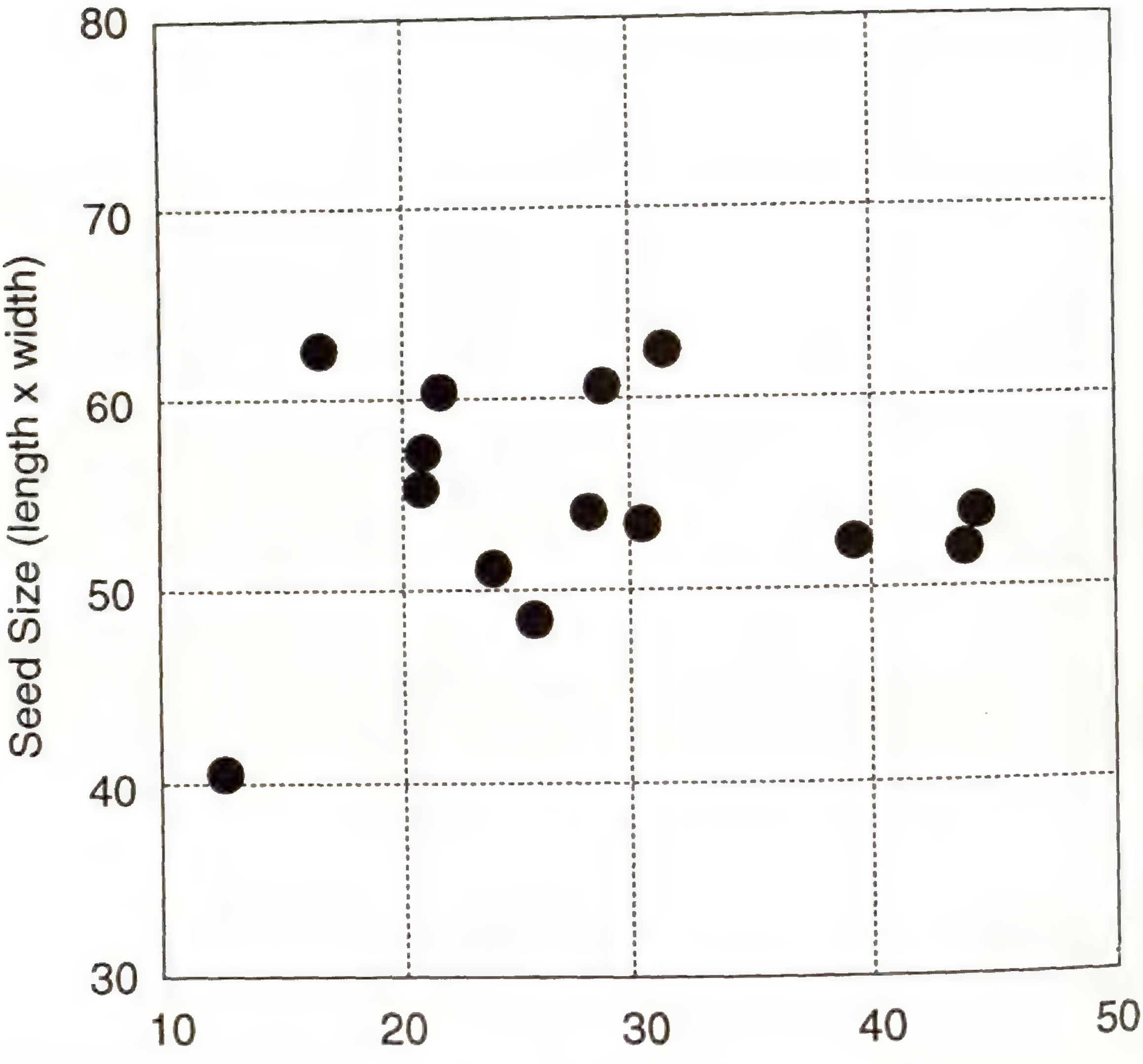


FIG. 6.—Bivariate plot of the relationship between seed size (length × width) and fruit size (fruit height × fruit diameter). The random scatter of the points suggests little relationship between seed and fruit size.

deviations of the lengths and widths of the seeds of these populations (e.g., Fig. 7). In general, seed width is far less variable than length. This variation is most noticeable in the cultivars and in the archaeological population from Phillips Spring. Using coefficient of variation as a measure of relative homogeneity produces a second, and perhaps more revealing result (Fig. 8). The free-living Ozarks populations occupy an intermediate position between most archaeological cucurbits and modern cultivars of *C. pepo* ssp. *ovifera,* while the Hontoon Island, Cloudsplitter, and modern *C. pepo* ssp. *ovifera* var. *texana* samples represent relatively homogeneous populations. Both the modern cultivars and the Phillips Spring population possess larger coefficients of variation. In part the large CV value for modern cultivars is the result of pooling varieties with radically different fruit morphologies. As such, the large CV value from Phillips Spring may indicate that

TABLE 4.—Summary statistics for various *Cucurbita* seed populations.

| Population | N[1] | Mean Length | CV | Mean Width | CV |
|---|---|---|---|---|---|
| Ozarks | 300 | 9.2 | 5.4 | 5.9 | 6.6 |
| Texana | 60 | 9.6 | 2.1 | 6.2 | 3.7 |
| Cultivars | 70 | 9.3 | 9.0 | 5.8 | 6.8 |
| Cloudsplitter | 2 | 8.7 | 1.6 | 5.4 | 5.1 |
| Phillips Spr.[2] | 49 | 10.2 | 8.7 | 6.9 | 9.1 |
| Hontoon Is–SN | 149 | 8.8 | 3.5 | 5.8 | 5.3 |
| Hontoon Is–SH | 868 | 9.0 | 2.2 | 6.0 | 1.5 |
| Hontoon Is-1 | 1,094 | 8.9 | 3.0 | 5.9 | 3.8 |

[1]N = numbers of seeds measured; CV = coefficient of variation; Ozarks = pooled sample of seeds from 15 fruits; Cultivars = pooled sample of C. *pepo* ssp. *ovifera* reported by Decker and Wilson 1986; Texana = C. *pepo* ssp. *ovifera* var. *texana* reported by Decker and Wilson 1986; Cloudsplitter = Cloudsplitter shelter, Kentucky, seeds measured by Cowan; Phillips Spr. = Phillips Spring, Missouri, seeds measured by Smith; Hontoon Island-SN = "Snail Midden" complete seeds; Hontoon Is-SH = "Mussel Midden" complete seeds, Hontoon Is-1 = combined proveniences, including a shell-free midden. Hontoon Island measurements provided by Lee Newsom.

[2]In her landmark study, King (1985) had a larger collection of seeds available for study than was considered here. As a result, she obtained slightly larger mean length (10.5 mm) and mean width (7.0) values from a sample of 65 Phillips Spring seeds.

more than one type was present at this locale (see King 1985, who reached a similar conclusion).

Based upon these data, seed size alone does not allow one to distinguish the seeds of the present-day, *or* archaeological cultivated *pepo* gourds from those of the wild Texas gourd and Ozark populations of *Cucurbita pepo* gourds. While seed size of cultivated ornamentals seems more variable (as expressed by standard deviation and the coefficient of variation), this is hardly a useful measurement if dealing with archaeological collections of only one or a few seeds. Again, while it is possible to suggest that archaeological *pepo* seeds longer than 11 mm represent domesticates (Smith 1992:45), a single seed smaller than 10 mm in length might come from either a wild or domesticated fruit. In such cases, archaeological context and direct date play an important role in assigning wild versus domestic status.

*Seed and rind bitterness*.—Chemical compounds in both the rind and flesh of truly wild *Cucurbita pepo* gourds impart a bitter taste. These cucurbitacins probably serve to deter fruit predation by vertebrate and invertebrate fauna. They also render the fruits virtually inedible to humans. The fact that all cultivated forms of C. *pepo* as well as many cultivars of C. *pepo* ssp. *ovifera* possess nonbitter flesh implies that the domestication process involved loss of cucurbitacins.

With the exception of a few specimens that exhibited introgression with domesticated plants, and contained only a few large seeds, the more than 400 gourds collected during the present study contained large numbers of small seeds (100–200) that were usually bitter tasting because placental tissue adhered tightly to the seed

FIG. 7.—Mean seed length and width plotted with one standard deviation showing degree of overlap of distributions.

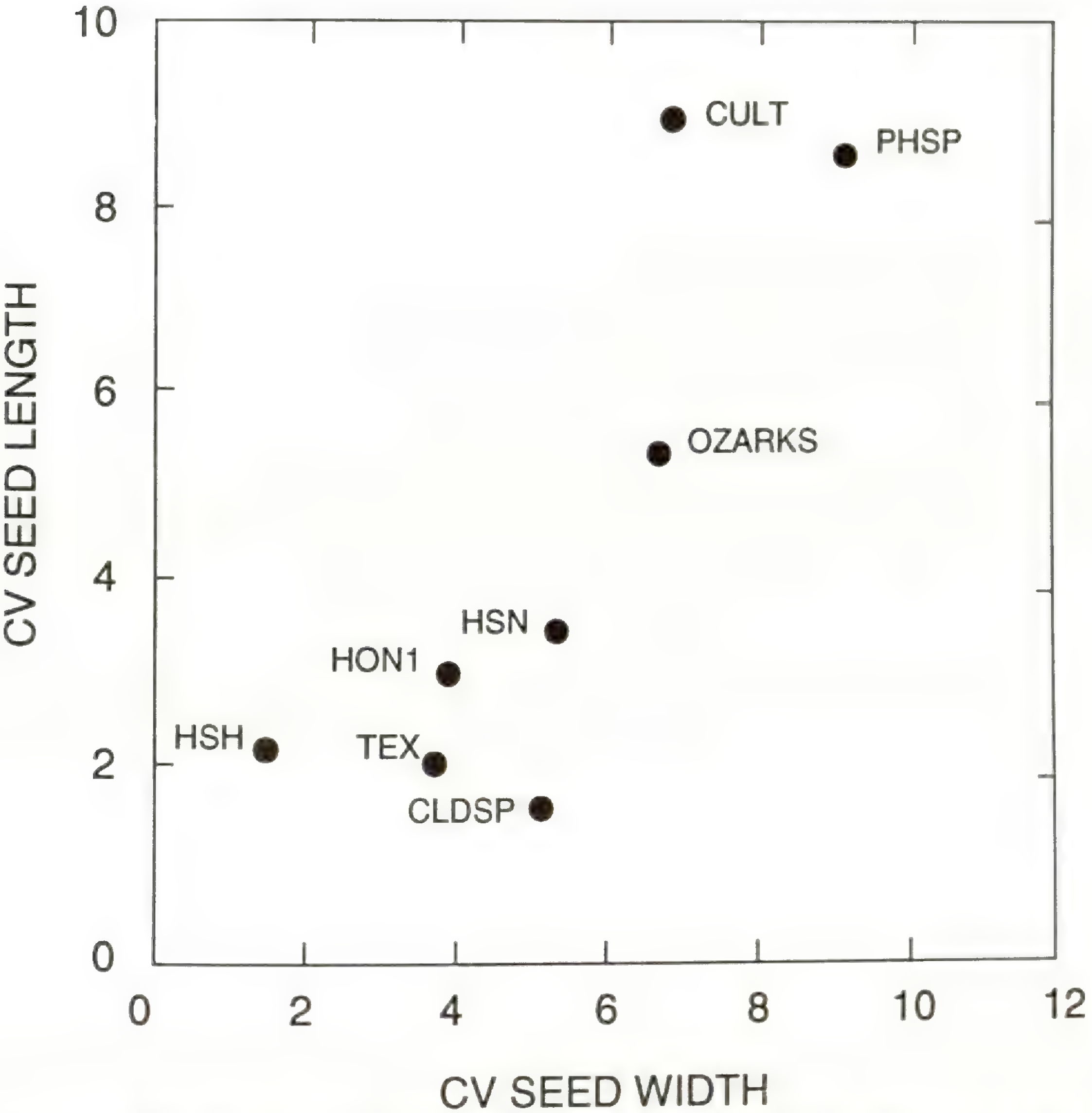


FIG. 8.—Bivariate plot of the relationship between coefficients of variation of seed length and seed width. Key to symbols: HSH (Hontoon Island shell layer), Hon1 (Hontoon Island), HSN (Hontoon Island snail layer). All measurements supplied by Lee Newsom; TEX (*Cucurbita pepo* ssp. *ovifera* var. *texana*, Decker and Wilson 1986, Table 3); CLDSP (Cloudsplitter Shelter, KY; measured by Cowan); OZARKS (free-living Missouri and Arkansas *Cucurbita pepo* gourds; this study); PHSP (Phillips Spring, MO; measured by Smith); CULT (modern cultivated *Cucurbita pepo* ssp. *ovifera*, Decker and Wilson 1986, Table 3), including "nest egg," "white egg," "flat striped," "bicolor pear," "striped pear," and "white pear").

coat. Production of a large number of bitter tasting seeds is contrary to the Asches' characterization of this plant as lacking these attributes of a successful pioneering species (Asch and Asch 1992), and is consistent with a successful adaption to natural floodplain environments. Of the fruits collected during our survey, and those sent to us by other collectors, only a handful produced nonbitter seeds. Interestingly, field observations at the time these fruits were collected led us to believe each was from a plant that had hybridized with domesticated *C. pepo*.

The fact that the overwhelming majority of free-ranging cucurbits we examined have extremely bitter flesh and seeds is another important component of the arguments favoring a truly wild status for these populations. When hybridization between wild and cultivated *pepo* squashes occurs, bitterness is lost. The lack of "sweetness" in our collections suggests little exchange of genetic material between domesticated and wild squashes.

Our survey also demonstrated the potential economic impact of wild gourds for human foragers. While it is virtually impossible to remove placental tissue from seeds, boiling the seeds for 5–10 min is sufficient to render them palatable. The implications of this simple processing technique are straightforward: wild gourd seeds can be added to a list of economically important annuals utilized in the East in the fourth millennium before the present.

As we have noted elsewhere, large "patches" of gourds can produce prodigious quantities of fruits. For example, a single patch on the Buffalo River covering about 200 square meters produced over 100 fruits containing 10,000–20,000 seeds (Smith et al. 1992:94). Under cultivated conditions, wild gourds could be expected to produce even greater quantities. Preliminary analysis of the nutritional qualities of wild gourd seeds suggests that more than 24% of their dry weight is high-quality protein (D. Smith 1992); this equals the protein content of domesticated sunflower (24%), and approaches that of sumpweed (32.25%) (Smith 1992, Table 9.3). Smith's analysis assayed the content of the entire seed (including the nondigestible seed coat); assay of the kernel only might be comparable to domesticated *C. pepo* (Smith 1992, Table 9.3).

*Peduncle absciscence and diameter.*—Whenever possible, peduncles were collected with each fruit, but most fruits had already abscised from the vines. In general, this seemed to be a function of latitude and altitude; more southerly, lower elevation collections were generally less mature, and fruits more likely to be retained on the plant. Even when fruits were found on the vine, however, it was difficult to remove both the fruit and peduncle from the vine without having the fruit detach from the peduncle. Fruits often abscised from the peduncle with the slightest tug. Andres (1987) has noted this peculiarity in var. *texana,* and suggests it represents an adaptive strategy that allows fruits to be readily dispersed during floods.

Recent collections of *C. pepo* ssp. *ovifera* and *C. pepo* suggest that absciscence among cultivated ornamental gourds and squashes and pumpkins is highly variable. Larger fruited forms of cultivated *C. pepo* (acorn squash, Connecticut field pumpkin) remain firmly attached to the vine long after fruits mature. On the other hand, absciscence in ornamental gourds varies from one variety to the next. In recent collections of mixed ornamentals, the senior author noted that forms such as "Green-striped pear" were most susceptible to falling free of the vine. Warty fruits were the most persistent; rarely could a fruit be collected without breaking the peduncle from the vine. Green striped, oblate, or cheese-shaped forms were intermediary between the "pear" forms and the "warty" ones.

Peduncles on Ozark gourds are uniformly five-angled, a common character of all varieties of *C. pepo.* In a sample of 20 fruits and associated peduncles, diameters (maximum distance between two points at the peduncle base) ranged from 5.3–8.6 mm, with a mean of 6.6 mm (standard deviation 0.79 mm) (Table 5). This measurement

TABLE 5.—Peduncle diameter and fruit size in free-living Ozark and cultivated Ohio *Cucurbita* gourds.

| | Peduncle Diameter (mm) | Maximum Fruit Height (cm) | Maximum Fruit Diameter (cm) |
|---|---|---|---|
| **Ozark Sample**[1] | | | |
| 33 | 6.1 | 5.5 | 4.7 |
| 39 | 6.7 | 5.6 | 4.8 |
| 40 | 5.6 | 5.0 | 4.2 |
| 42 | 6.5 | 5.4 | 4.8 |
| 44 | 5.9 | 5.6 | 4.5 |
| 48 | 6.2 | 5.5 | 4.8 |
| 123 | 6.6 | 8.9 | 5.2 |
| 124 | 5.3 | 7.6 | 4.5 |
| 125 | 5.9 | 5.2 | 4.6 |
| 133 | 6.3 | 5.7 | 5.3 |
| 166 | 7.6 | 5.0 | 5.0 |
| 167 | 7.6 | 5.3 | 4.5 |
| 168 | 7.3 | 4.6 | 4.5 |
| 285 | 6.4 | 5.7 | 4.7 |
| 286 | 6.3 | 5.1 | 4.4 |
| 288 | 5.8 | 4.0 | 3.9 |
| 301 | 7.3 | 4.9 | 5.4 |
| 309 | 6.6 | 5.0 | 5.2 |
| 389 | 8.6 | 6.6 | 6.7 |
| 399 | 6.9 | 6.0 | 5.8 |
| Sample Mean = | 6.6 | Std. Dev. .80 | |
| **Cultivar Sample**[2] | | | |
| 1 | 8.5 | 4.7 | 8.5 |
| 1 | 8.3 | 4.8 | 8.0 |
| 1 | 10.0 | 4.5 | 7.7 |
| 1 | 12.4 | 4.7 | 8.6 |
| 2 | 7.5 | 4.2 | 4.3 |
| 2 | 6.4 | 4.9 | 4.5 |
| 2 | 6.2 | 4.2 | 3.9 |
| 3 | 8.0 | 6.2 | 8.8 |
| 3 | 7.0 | 6.4 | 8.7 |
| 3 | 7.9 | 6.1 | 9.4 |
| 3 | 7.0 | 6.6 | 9.3 |
| 3 | 9.0 | 4.5 | 7.5 |
| 4 | 13.7 | 7.2 | 7.1 |
| 4 | 12.0 | 7.3 | 7.4 |
| 4 | 15.0 | 11.5 | 8.5 |
| 4 | 11.0 | 11.7 | 6.9 |
| 4 | 10.0 | 6.3 | 6.8 |
| 4 | 10.0 | 6.4 | 7.1 |
| 4 | 15.1 | 8.3 | 9.2 |
| 4 | 14.9 | 8.2 | 8.2 |

TABLE 5.—Peduncle diameter and fruit size in free-living Ozark and cultivated Ohio *Cucurbita* gourds. (continued)

| | Peduncle Diameter (mm) | Maximum Fruit Height (cm) | Maximum Fruit Diameter (cm) |
|---|---|---|---|
| **Cultivar Sample**[2] | | | |
| 4 | 13.0 | 8.0 | 8.2 |
| 4 | 11.3 | 7.1 | 7.2 |
| 4 | 10.0 | 6.4 | 7.2 |
| 4 | 12.9 | 5.2 | 8.7 |
| | Sample Mean = 10.3 | Std. Dev. 2.9 | |

[1]Ozark Cat. Nos. 33–48 Spavinaw Creek, Benton County, AK; 123–133 Wilbur Allen Wildlife Refuge, Gasconade River, Wright County, MO; 166–168 Maumee Landing, Buffalo River, Searcy County, AK; 285–286 Highway 14 Bridge, Buffalo River, Searcy County, AK; 288–309 Highway 9 Bridge, White River, Izard County, AK; 389–399 Red River, Bossier Parish, LA.

[2]Cultivars (all from field of mixed ornamental *C. pepo* ssp. *ovifera* growing in Hamilton County, Ohio). 1 Green and white striped, with shallow lobes, oblate shaped; 2 yellow-striped, slightly warty and lobed; 3 dark green stripes on light green background, slighted lobed and slightly warty, oblate shaped; 4 yellow warted, oblate to pyriform shaped.

was significantly larger (mean 9.75 mm, range 6.2–15.1 mm, standard deviation 2.8 mm) in a sample of 23 peduncles of mixed cultivated *ovifera* fruits.

Peduncle diameter in *Cucurbita pepo* is clearly related to fruit volume. This is visually obvious when comparing the large fruits of some cultivated *pepos,* but is less so for cultivated ornamentals and free-ranging gourds. A comparison of individual peduncle diameters from cultivated ornamentals from southwest Ohio and free-ranging Ozark fruits serves as an objective measure of this relationship, and clarifies the utility of the peduncle in determining wild versus cultivated status of small *pepo* forms. As illustrated in Fig. 9, most free-ranging gourds produce peduncles and fruits that are smaller than cultivated *C. pepo* ssp. *ovifera*. While there is overlap in the size distributions, we believe peduncle diameter is probably useful for determining whether archaeological specimens are cultivated or wild if one has a collection of sufficient size. We suggest, for example, that *in general,* peduncles with diameters of 8 mm or less are probably from wild fruits, and those with diameters larger than this are likely domesticated. Since peduncle diameters of wild and cultivated forms overlap, however, this cut-off is best used with caution. And, like rind and seed measurements, archaeological sample size limits the utility of any peduncle diameter "index" in distinguishing between wild and early domesticated forms.

## SUMMARY OF MORPHOLOGICAL CHARACTERISTICS AND THEIR INTERPRETIVE VALUE FOR ARCHAEOLOGICAL COLLECTIONS

Morphological characteristics of *Cucurbita pepo* gourd populations from the Ozarks provide baseline information useful in evaluating wild versus domesticated status of modern and archaeological specimens. In particular, these data suggest that the following characteristics can be used as markers of domestication:

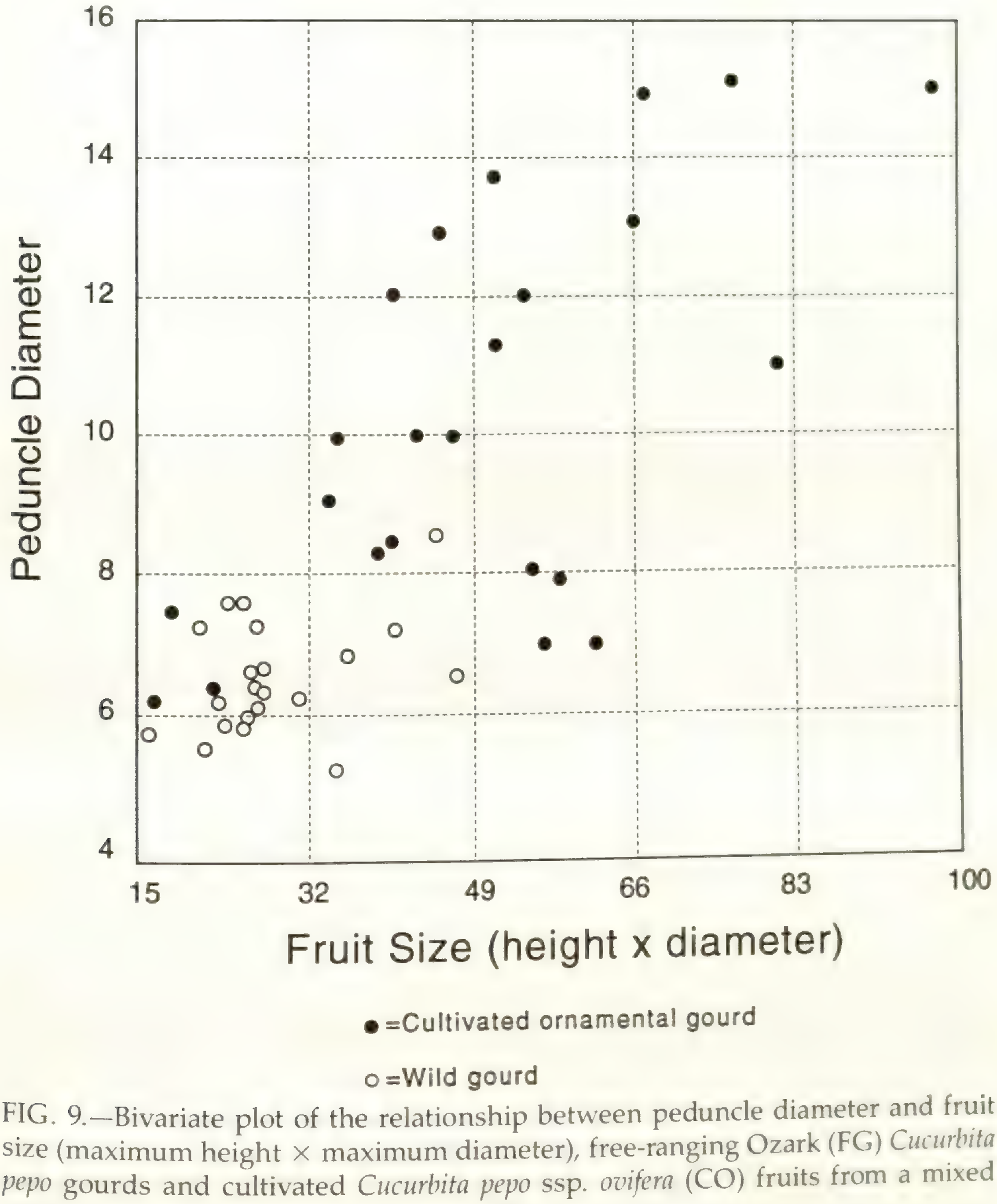


FIG. 9.—Bivariate plot of the relationship between peduncle diameter and fruit size (maximum height × maximum diameter), free-ranging Ozark (FG) *Cucurbita pepo* gourds and cultivated *Cucurbita pepo* ssp. *ovifera* (CO) fruits from a mixed population grown in Hamilton County, Ohio.

(1) rind thickness which exceeds 2 mm;
(2) epidermal lobing and/or warting;
(3) seed length greater than 11 mm; and
(4) peduncle diameter exceeding 8 mm.

These guidelines for identifying wild versus domesticated *pepo* do little to alter the current model of the appearance of truly domesticated *Cucurbita pepo* in eastern North America (see Smith et. al 1992, Chapters 3 and 4). After an unknown period of use of wild gourds similar, if not identical, to those growing in the

Ozarks today, domestication occurred sometime between about 4300–3000 B.P. The Phillips Spring assemblage (ca. 4300 B.P.) is important in this regard, in that it might represent an early stage of domestication. Length and width of Phillips Spring gourd seeds, and their range of variation, fall on the edge, or outside the range of wild forms, while peduncle diameter and rind thickness fall well below the boundary lines of domestication.

## FREE-LIVING *Cucurbita pepo* GOURDS: SUMMARY

Based on limited published references, information from herbarium sheets, and field studies, an initial outline of the most obvious aspects of the niche and habitat of free-living *Cucurbita pepo* gourds can be offered.

The free-living *Cucurbita pepo* gourd of eastern North America exhibits a highly successful specific adaptation to stream and river valley floodplain habitats. These gourds are the first to occupy and grow in stream-side gravel and sand bar, bank, and terrace settings where few other plants match their colonizing abilities. The buoyant gourds are often trapped by weeds, bushes, and other floodwater "filters," or are deposited with other floodborne materials in debris piles. Whether the context of deposition is stream-side sand and gravel bars and hummocks, as documented along the smaller streams and rivers of the Ozarks, or the higher elevation sandy terraces and levee ridges of larger river valleys, gourds colonize open edge areas within the constantly reworked floodplain landscape. These sunny to partly shaded habitats constitute the annually disturbed habitat setting within which *Cucurbita pepo* gourds are strong and successful competitors. With rapidly growing vines that can extend for more than 30 meters along the ground and climb 3–4 m into trees and other vegetation, these gourds also exhibit impressive means of reaching sunlight and displaying their blossoms to pollinators.

Although sometimes occurring in concentrated populations, isolated plants can also be dispersed widely along floodplain corridors. With their capacity for self-pollination, isolated plants are not disadvantaged by wide floodwater dispersal. Contrary to the Asches' assertion, there is no evidence that var. *texana* (or any of the free-living *Cucurbita pepo* gourds) do not have the ability to self-pollinate (Deena Decker-Walters, personal communication, 1992).

These adaptational aspects of free-living gourds—buoyant, hard-walled fruit functioning for efficient seed dispersal by floodwaters, aggressive climbing and growth characteristics of vines, prolific gourd and seed production, and self-pollination—all suggest long-term evolution within, and adaption to, river floodplain environments. This adaption also proves advantageous for colonizing human-maintained floodplain habitats such as bridge approaches, drainage ditches, and agricultural fields. This plant's well documented ability to infest fields within the reach of floodwaters chronically certainly qualifies it as a floodplain agricultural weed of the first rank. But as indicated by the above habitat descriptions, it is a mistake to characterize the free-living gourds narrowly as agricultural weeds, and certainly in error to view them as closely associated with soybean cultivation. On the contrary, it is important to begin any characterization of free-living *Cucurbita pepo* gourds with a recognition of their successful adaptation to naturally dis-

turbed floodplain environments, and to then view their success in anthropogenic contexts as the simple expansion of the plant into areas where human activities have expanded, sometimes dramatically, the habitat of the plant.

Based upon information collected from a survey of archaeological literature, herbaria holdings, and field and laboratory observations, we have been able to document the following:

(1) Archaeological evidence of a morphologically wild *Cucurbita pepo* gourd is present in broad areas of the East spanning a period of nearly 12,000 years.
(2) Historical evidence of this same plant can be traced from the discovery of *Cucurbita pepo* ssp. *ovifera* var. *texana* in 1835, and throughout the remainder of the nineteenth and early twentieth centuries in the central Mississippi valley where a wild morphotype gourd has been repeatedly collected since 1846.
(3) Contemporary free-ranging gourds scattered throughout the Southeast and Midwest differ markedly in morphology from cultivated ornamentals.
(4) Rather than narrow niche agricultural companion weeds, free-ranging gourds are well adapted members of riparian plant communities and thrive in habitats far removed from agricultural settings. Although the same gourds do invade cultivated fields, they are by no means tied to such human-maintained habitats.

While ongoing analyses of archaeological materials and contemporary collections will undoubtedly flesh out the relationships between cultivated forms of *C. pepo* ssp. *ovifera* and free-living *Cucurbita pepo* gourds of eastern North America, we believe there is little need to rely on Mexico as the "hearth" from which cucurbits diffused into eastern North America. Indeed, these data call into question the early radiocarbon dates associated with cucurbits in Mexico. The cucurbit collections from the central and northern Mexican cave and rockshelter sites should be radiometrically dated.

There is ample evidence that a wild indigenous gourd has existed in the East for thousands of years. We believe this gourd to have been the progenitor for many of today's *pepo* squashes. The companion article by Decker-Walters et al. in this journal issue provides further, and we think, compelling support for this position.

## NOTES

[1]Taxonomy of *Cucurbita pepo* follows Decker-Walters (1990). We refer to *C. pepo* ssp. *ovifera* var. *texana* as the Texas wild gourd or var. *texana* in the text. We use the term *C. pepo* gourd to refer to the ornamental domesticated gourds (*C. pepo* ssp. *ovifera*) and the free-ranging varieties (Texas gourd and *C. pepo* ssp. *ovifera* var. *ozarkana;* see Decker-Walters et al., this volume).

[2]The following seed catalogues are cited in the text. All are on file at the United States Department of Agriculture, National Agricultural Library in Beltsville, Maryland.

BLISS, B.K. 1860. A Descriptive Catalogue Containing a Choice Collection of Flower, Vegetable, and Agricultural Seeds. Eighth annual edition. Springfield, Massachusetts.

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HOVEY and COMPANY. 1845. Descriptive Catalogue of a Choice Collection of Flowers and Seeds. Boston.

M'MAHON, BERNARD. 1804. Catalogue of American Seeds. Philadelphia
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O'KEEFE, M. and SONS COMPANY. 1868. Catalogue of Seeds and Guide to the Flower and Vegetable Garden. Rochester, New York.
PRINCE, WILLIAM and SON'S. 1834–35. Annual Catalogue of Esculent Vegetables and other Seeds of the Choicest American and Imported Varieties.
SIBLEY, HIRAM COMPANY. 1879. Catalogue of Garden, Field, and Flower Seeds. Rochester, New York and Chicago.
VICK, JAMES. 1866. Vick's Illustrated Catalogue of Seeds and Guide to the Flower Garden. Rochester, New York.

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# ISOZYMIC CHARACTERIZATION OF WILD POPULATIONS OF *Cucurbita pepo*

DEENA S. DECKER-WALTERS
*Fairchild Tropical Garden*
*11935 Old Cutler Road*
*Miami, FL 33156*

TERRENCE W. WALTERS
*Fairchild Tropical Garden*
*11935 Old Cutler Road*
*Miami, FL 33156 and*
*Department of Biological Sciences*
*Florida International University*
*Miami, FL 33199*

C. WESLEY COWAN
*Cincinnati Museum of Natural History*
*1720 Gilbert Ave.*
*Cincinnati, OH 45202*

BRUCE D. SMITH
*National Museum of Natural History*
*Smithsonian Institution*
*Washington, D.C. 20560*

ABSTRACT.—Isozyme data were collected from 20 wild populations of *Cucurbita pepo* ssp. *ovifera* var. *ozarkana* recently discovered in Arkansas, Illinois, Kentucky, Louisiana, Missouri, and Oklahoma. Comparison of these data to similar data generated for populations in Texas (ssp. *ovifera* var. *texana*) and Tamaulipas, Mexico (ssp. *fraterna*), Mexican landraces (ssp. *pepo*), and cultivars representing both major genetic lineages (ssp. *ovifera* var. *ovifera* and ssp. *pepo*) revealed a distinct isozyme profile, including the characteristic allele *Idh-2m,* for the non-Texas U.S. populations. About half these populations exhibited signs of limited and, in many cases, recent introgression from cultivars. Genetic similarity and the patterns of variation between ssp. *ovifera* var. *ozarkana* and var. *ovifera* lead us to conclude that ancient populations of the former gave rise to the latter. Populations of ssp. *fraterna* from northeastern Mexico also exhibited a unique isozyme profile with affinities to both major cultivar lineages. None of the wild populations exhibited a particularly close relationship to Mexican landraces of ssp. *pepo,* leading us to hypothesize that progenitor populations of these landraces probably occurred farther south in Mexico and may be extinct. In conclusion, the isozyme data revealed that within the range of wild *C. pepo,* genetic divergence took place long before domestication and over an extensive period of time in at least four disjunct and ecologically distinct regions—the central Mississippi valley/Ozark Plateau, Texas, northeastern Mexico, and central or southern Mexico.

RESUMEN—Se colectaron datos de isozimas de 20 poblaciones silvestres de *C. pepo* ssp. *ovifera* var. *ozarkana* descubiertas recientemente en Arkansas, Illinois, Kentucky, Louisiana, Missouri y Oklahoma. La comparación de estos datos con datos similares generados para poblaciones en Texas (ssp. *ovifera* var. *texana*) y Tamaulipas, México (ssp. *fraterna*), variedades mexicanas cultivadas tradicionalmente (ssp. *pepo*), y cultivares que representan los dos linajes genéticos principales (ssp. *ovifera* var. *ovifera* y ssp. *pepo*) reveló un perfil isozimático distintivo, incluyendo el alelo característico *ldh-2m*, para las poblaciones de los Estados Unidos de Norteamérica fuera de Texas. Alrededor de la mitad de estas poblaciones mostraron señas de una introgresión de cultivares, limitada y en muchos casos reciente. La similitud genética y los patrones de variación entre la ssp. *ovifera* var. *ozarkana* y la var. *ovifera* nos conducen a concluir que las poblaciones antiguas de la primera dieron origen a la segunda. Las poblaciones de la ssp. *fraterna* del noreste de México también mostraron un perfil isozimático peculiar con afinidades a los dos linajes principales de cultivares. Ninguna de las poblaciones silvestres mostró una relación particularmente cercana a las variedades mexicanas tradicionalmente cultivadas de la ssp. *pepo*, llevándonos a la hipótesis que las poblaciones progenitoras de estas variedades probablemente se daban más al sur en México y posiblemente se hayan extinguido. En conclusión, los datos de isozimas revelan que dentro del área de distribución de la *C. pepo* silvestre, la divergencia genética tuvo lugar mucho antes de la domesticación y a lo largo de un extenso período de tiempo en por lo menos cuatro regiones geograficamente separadas y ecologicamente diferentes: la región central del Valle del Mississippi junto con la altiplanicie Ozark, Texas, el noreste de México, y el centro o sur de México.

RESUME.—Des données d'isozymes ont été rassemblées, provenant de 20 populations sauvages de *C. pepo* ssp. *ovifera* var. *ozarkana* récemment découvertes dans l'Arkansas, l'Illinois, le Kentucky, la Louisianne, le Missouri, et l'Oklahoma. Des comparaisons faites entre ces données et celles obtenues sur des populations du Texas (ssp. *ovifera* var. *texana*) et de Tamaulipas, Mexico (ssp. *fraterna*), des races mexicaines (ssp. *pepo*), et des "cultivars" representant les deux lignées génétiques principales (ssp. *ovifera* var. *ovifera* et ssp. *pepo*) ont revélé un profile d'isozymes distinct, comprenant le gène (allèle) charactéristique *Idh-2m*, pour la population non-Texanne des USA. A peu près la moitié de ces groupes exhibe des signes d'introgréssion limitée, et, dans plusieurs cas, récente, de "cultivars." La resemblance génétique et le genre de variation entre ssp. *ovifera* var. *ozarkana* et var. *ovifera* nous entraine à conclure que des populations anciennes du premier sont ancestrales à celles du deuxième. Des groupes de ssp. *fraterna* du Nord-Est du Méxique exhibent aussi un profile d'isozyme unique, exhibant des affinitées avec les deux lignées principales. Aucune des populations sauvages exhibent une parenté particulièrement proche des races de ssp. *pepo* du Méxique, ce qui nous amène a supposer que les populations ancestrales de ces races se trouvaient probablement plus au Sud du Méxique, et sont peut-être éteintes. En conclusion, les données d'isozymes ont révelé qu'au sein de l'étendue de *C. pepo* sauvage, une divergence génétique a pris place longtemps avant la domestication, s'étendant sur une longue période, dans 4 régions non-adjacentes et écologiquement distinctes—la vallée du Mississippi central/région du Plateau Ozark, le Texas, le Nord-Est du Méxique, et le centre ou le Sud du Méxique.

## INTRODUCTION

As one of the earliest New World domesticates, squash (*Cucurbita pepo* L.) has great impact on theories of horticultural origins in North America. A greater understanding of the evolutionary history of this species has led to the suggestion that squash domestication took place independently twice to produce the two major lineages of cultivars, *C. pepo* ssp. *ovifera* (L.) Decker var. *ovifera* (L.) Decker and *C. pepo* ssp. *pepo* (Decker 1988). Subspecies *pepo,* which comprises pumpkins, marrows, Mexican landraces, and a few ornamental gourds, apparently has its origins in Mexico, whereas ssp. *ovifera* var. *ovifera,* which includes scallop and crookneck squashes and most ornamental gourds, appears native to the eastern United States (Decker 1988; Decker-Walters 1990). In the past, examination of wild populations that might have given rise to the cultivar lineages was limited to several populations of *C. pepo* ssp. *ovifera* var. *texana* (Scheele) Decker in Texas and a few morphologically similar populations in Alabama, Arkansas, Illinois, and Missouri (Decker and Wilson 1987). Isozyme analyses indicated that these populations were remnants of ancestral wild *C. pepo* and were not merely cultivar escapes (Decker and Wilson 1987). Consequently, var. *texana* became the likely candidate for the progenitor of the var. *ovifera* cultivars. Although isozyme data were lacking at the time, Decker-Walters (1990) hypothesized that *C. pepo* ssp. *fraterna* (Bailey) Andres, which occurs in northeastern Mexico, was the wild progenitor of the ssp. *pepo* lineage of cultivars. No other wild taxa of *C. pepo* are currently recognized.

Recently, a few populations of ssp. *fraterna* became available for isozyme analysis (cf. Wilson 1989). Additionally, a much greater number of wild populations occurring north of Texas were discovered by various collectors (Smith et al. 1992). Because the solid ivory fruits of these northern populations differed from the striped fruits of var. *texana* and ssp. *fraterna,* we decided to look for other genetic evidence distinguishing these populations. Therefore, we collected isozyme data on these and other populations to clarify further the evolutionary relationships within *C. pepo,* particularly those between wild populations and the two domesticated lineages.

## MATERIALS AND METHODS

For purposes of this study, all wild populations occurring north of Texas were considered unclassified, whereas only those populations in Texas were treated as belonging to *Cucurbita pepo* ssp. *ovifera* var. *texana.*

We surveyed isozymes in 20 wild populations of *C. pepo* occurring in states north and east of Texas, six populations of ssp. *ovifera* var. *texana,* two populations of *fraterna,* four cultivars of ssp. *ovifera* var. *ovifera,* and eight cultivars and Mexican landraces of ssp. *pepo* (Tables 1 and 2; Fig. 1). In some analyses, we considered previously collected isozyme data on six non-Texas U.S. populations (Decker and Wilson 1987), 12 additional populations of ssp. *ovifera* var. *texana* (Decker and Wilson 1987), three populations of ssp. *fraterna* (Wilson 1989), and approximately 200 cultivars and landraces (not including Acorn group cultivars) representing ssp. *ovifera* var. *ovifera* and ssp. *pepo* (Decker 1985, 1986; Decker-Walters et al. 1990; Ignart and Weeden 1984; Wilson 1989). Existing data on the closest extant wild relative of *C. pepo, C. argyrosperma* Huber ssp. *sororia* (Bailey) Merrick and Bates (Decker 1986; Wilson 1989), gave us a broader evolutionary perspective on variation within *C. pepo.*

TABLE 1.—Accession and sampling information on 28 wild populations of *Cucurbita pepo,* including ssp. *fraterna* (FRA), var. *texana* (TEX), and related populations (?).

| Accession[1] | State/ Country | County | River/ Creek | No. inds. samp. | No. plants repr. | No. fruits repr. | Reference Numbers[2] |
|---|---|---|---|---|---|---|---|
| ?AR 801 | AR | Benton | Osage | 10 | ? | 6 | AB 1-6 |
| 802 | AR | Searcy | Buffalo | 11 | 11 | 11 | AB 201 205 217 226 235 239 241 262 278 282 285 |
| 803 | AR | Benton | Spavinaw | 10 | ? | 10 | AB 16 18 23 25 27 28 31-34 |
| 804 | AR | Benton | Little Sugar | 8 | ? | 8 | AB 7 9 10 55 57 72 74 75 |
| 818 | AR | Searcy | Buffalo | 9 | 1 | 9 | AB 183-187 189-192 |
| 819 | AR | Izard | White | 9 | 5 | 9 | AB 288-290 294 295 321 322 329 330 |
| 820 | AR | Independence | White | 8 | 2 | 8 | AB 362 364-366 373-375 378 |
| ?IL 812 | IL | Jersey | Illinois | 10 | ? | 2 | AB 108 109 |
| ?KY 813 | KY | Powell | Red | 9 | 1 | 1 | AB 110 |
| ?LA 811 | LA | Tenasas | Mississippi | 8 | 1 | 1 | AB 107 |
| 814 | LA | Bossier | Red | 13 | ? | 11 | AB 387-390 392 394 395 398-401 |
| ?MO 808 | MO | Christian | Wilson | 9 | ? | 3 | AB 80-82 |
| 809 | MO | Greene | James | 10 | ? | 2 | AB 83 84 |
| 810 | MO | Taney | Swan | 10 | ? | 10 | AB 86 90-98 |
| 815 | MO | Wright | Gasconade | 9 | 3 | 9 | AB 118 119 121 125 126 128 135-137 |
| 816 | MO | Wright | Gasconade | 13 | 2+ | 10 | AB 152 154-162 |
| 822 | MO | Ozark | Bryant | 14 | 1 | 7 | AB 111-117 |
| ?OK 805 | OK | Mayes | Verdigris | 9 | 1 | 1 | AB 13 |
| 806 | OK | Cherokee | Illinois | 12 | ? | 4 | AB 51-54 |
| 807 | OK | Adair | Illinois | 8 | ? | 2 | AB 99 100 |
| FRA 750 | MEX | Tamaulipas | — | 10 | ? | 8 | P.I. 532355 |
| 751 | MEX | Tamaulipas | — | 9 | ? | 5 | P.I. 532354 |
| TEX 747 | TX | Gonzales | Guadalupe | 11 | 11? | 11? | P.I. 285213 |
| 779 | TX | San Patricio | Aransas | 8 | ? | 8? | TEX 1 |
| 780 | TX | Refugio | Medio | 8 | ? | 4? | TEX 2 |
| 781 | TX | Goliad | San Antonio | 8 | ? | 7? | TEX 3 |
| 782 | TX | Gonzales | Guadalupe | 8 | ? | 8? | TEX 4 |
| 783 | TX | Fayette | Colorado | 8 | ? | 8? | TEX 5 |

[1]Accession numbers are the collection numbers of D. Decker-Walters and T. Walters.

[2]AB numbers are curation numbers assigned to fruits deposited in the Archaeobiology Laboratory at the National Museum of Natural History. P.I. numbers are U.S.D.A. Plant Introduction numbers. TEX numbers are from Decker and Wilson (1987).

TABLE 2.—Accession and sampling information on eight cultivars and four Mexican landraces of *Cucurbita pepo*.

| Taxon | Accession[1] | Cultivar/ Landrace | Source[2] | No. individuals sampled |
|---|---|---|---|---|
| ssp. *ovifera* | | | | |
| var. *ovifera* | FMA 467 | 'Mandan' | — | 11 |
| | OEN 538 | 'Nest Egg' | Nichols Garden Nursery | 8 |
| | OFS 774 | 'Flat Striped' | Stokes | 8 |
| | OPS 763 | 'Striped Pear' | J.L. Hudson | 8 |
| ssp. *pepo* | OBO 775 | 'Orange Ball' | Stokes | 9 |
| | OWO 765 | 'Orange Warted' | J.L. Hudson | 10 |
| | PCO 759 | 'Connecticut Field' | J.L. Hudson | 8 |
| | PSU 772 | 'Small Sugar' | Stokes | 8 |
| | XGU 777 | Mexican landrace | P.I. 512190 | 8 |
| | XHU 543 | Mexican landrace | Stokes | 8 |
| | XQU 778 | Mexican landrace | P.I. 512192 | 8 |
| | XYU 468 | Mexican landrace | — | 5 |

[1]Accession numbers are the collection numbers of D. Decker-Walters and T. Walters.

[2]All seed was obtained from seed companies or the U.S.D.A., except for FMA 467, which was contributed by G. Drowns, and XYU 468, which is $F_1$ seed of a self of P.I. 438699 created by T. Andres.

The following northern populations showed morphological signs (e.g., non-bitterness, large seeds, thick peduncles) of hybridization with cultivars: ?AR802, ?AR819, ?KY813, ?LO814, ?MO816 (Smith et al. 1992; Cowan and Smith, this volume). Morphological evidence of introgression was also discovered in wild populations from Illinois and Alabama (Decker and Wilson 1987).

We examined isozymes in five to 13 individuals per accession (Tables 1 and 2). Enzymes were extracted from 3- to 5-day-old cotyledons as described in Decker-Walters et al. (1990). We employed two buffer systems to resolve the following eight enzyme systems: on a citric acid/morpholine (pH = 6.7) system, isocitrate dehydrogenase (IDH), malate dehydrogenase (MDH), phosphoglucomutase (PGM), and shikimate dehydrogenase (SKD); and on the Poulik system (system #1 of Kirkpatrick et al. 1985), aspartate aminotransferase (AAT), glycerate dehydrogenase (G2D), glucose-6-phosphate isomerase (GPI), and leucine aminopeptidase (LAP). Recipes and additional details on the electrophoretic methodology are described elsewhere (Decker-Walters et al. 1990; Kirkpatrick et al. 1985).

Genetic interpretation was based on the nature of the banding patterns and on progeny segregation results from a cross of *C. pepo* ssp. *pepo* and ssp. *ovifera* var. *texana* performed by Kirkpatrick et al. (1985). As suggested by Kirkpatrick et al. (1985), the large number of loci detected for some enzymes (e.g., PGM) probably reflects gene duplication of a polyploid nature for the genus *Cucurbita*. However, progeny segregation analysis confirmed that species of this genus behave genetically as diploids (Kirkpatrick et al. 1985).

We resolved allelic variation at 18 enzyme loci: *Aat-1, Aat-3, Aat-4, G2d-1, G2d-2, Gpi-2, Gpi-3, Idh-1, Idh-2, Idh-3, Lap-1, Mdh-1, Mdh-2, Mdh-3, Pgm-1, Pgm-5,*

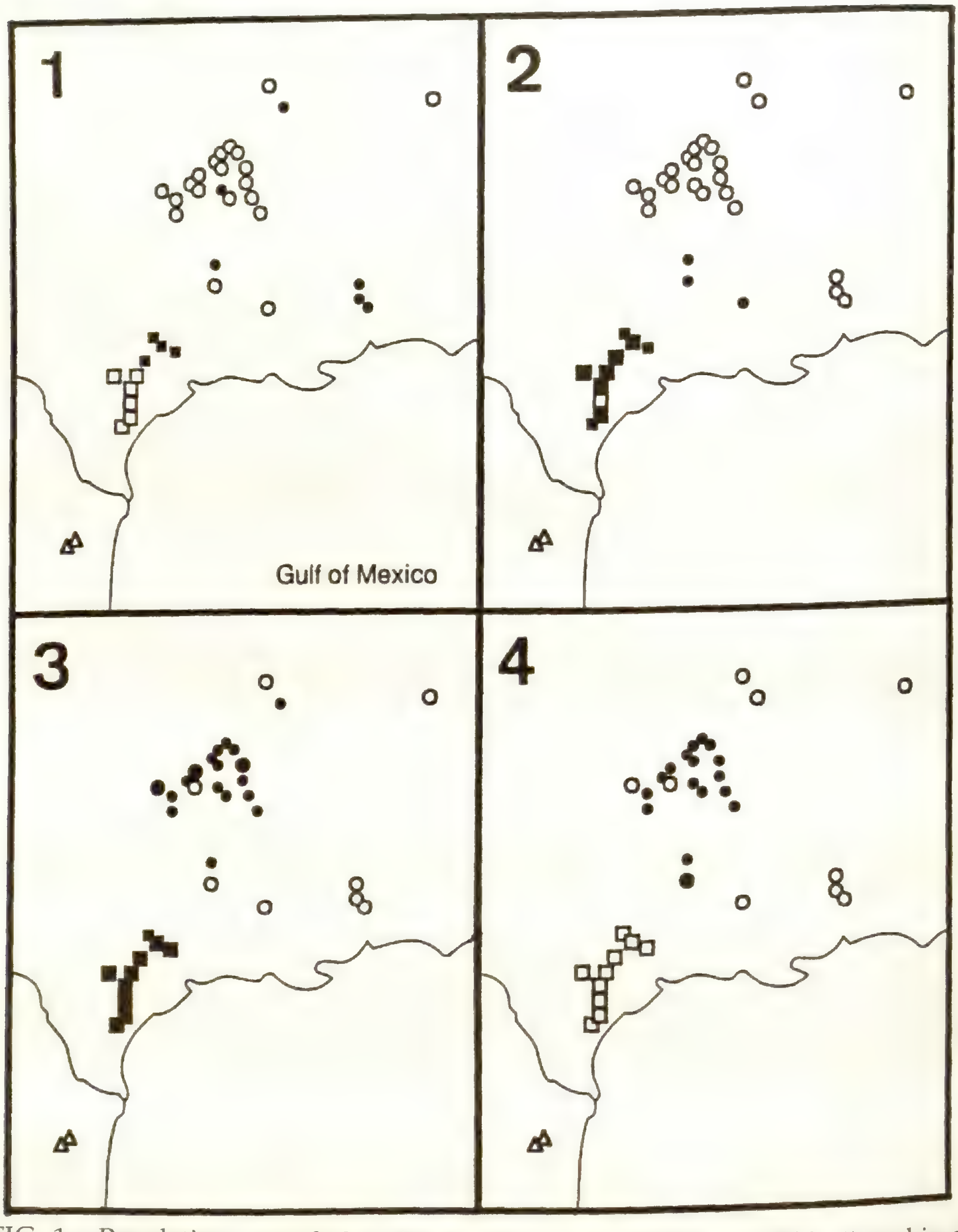


FIG. 1.—Populations sampled in this study (open symbols; see Table 1) and in a previous study (solid symbols; Decker and Wilson 1987). Triangles represent *Cucurbita pepo* spp. *fraterna,* squares represent ssp. *ovifera* var. *texana,* and circles represent unclassified wild populations. FIGS. 2-4.—Solid symbols indicate presence of a particular allele, with the larger of these indicating 100% frequency within the population. Triangles represent *Cucurbita pepo* spp. *fraterna,* squares represent ssp. *ovifera* var. *texana,* and circles represent unclassified wild populations. FIG. 2—*Idh-3o*. FIG. 3.—*Aat-1e*$^{-}$. FIG. 4.—*Idh-2m*.

*Pgm-6, Skd-1. Pgm-6* is equivalent to *Pgm-2* of previous reports (e.g., Decker 1985; Wilson 1989). We designated alleles in accordance with Kirkpatrick et al. (1985) and Decker-Walters et al. (1990) with the following exceptions: *Idh-1g* of previous studies has been renamed *Idh-1e* because results herein indicate that the enzyme product of this allele does not comigrate with that of *Idh-2g* on the gel. Note that Wilson (1989) interprets our *Idh-2m* (which we proposed in Decker-Walters et al. 1990) as a null or inactive variant (his *Idh-2z*). Because either interpretation is equally plausible based on currently known banding patterns, we have chosen to follow Decker-Walters et al. (1990) to be consistent with our previous work, while at the same time recognizing that the null interpretation may be correct. Our null variants are denoted with a superscripted "n" (e.g., *Lap-1f*$^{n}$).

The ability to detect first-generation hybridization is one of the advantages of isozyme data. Heterozygous conditions are clearly visible and when an individual is heterozygous for alleles typically not found in that taxon, it is often possible to determine the taxon that contributed the "foreign" pollen. The opportunity to document infraspecific hybridization is greater in *Cucurbita pepo* than in most species because there are at least two genetically distinct but interfertile lineages: ssp *pepo* and ssp. *ovifera* (Decker 1988). Consequently, we looked for signs of first-generation hybridization as well as longer histories of introgression in the isozyme data on the wild populations. First-generation hybridization could be postulated for an individual exhibiting a larger than normal percentage of heterozygous loci at which one of the alleles per locus rarely or never occurred in other members of the same population and/or taxon. Introgression beyond the first generation was suspected when one of these apparently foreign alleles was found in the homozygous state.

Other data analyses also focused on describing wild populations north of Texas and on comparing these populations to infraspecific taxa of *C. pepo* and to *C. argyrosperma* ssp. *sororia*. We mapped alleles in wild populations of *C. pepo* to look for geographical trends. Genetic affinities within *C. pepo* were illustrated via the plotted results of principal component analysis (PCA), which was performed using the Statistical Analysis System (SAS Institute Inc. 1985). Following Nei (1972), as in previous studies, we calculated genetic identity values within and among taxa using the data presented herein, except for data on *C. argyrosperma* ssp. *sororia*, which came from Decker (1986).

Drawing on all available sources of isozyme data (see above), we attempted to characterize each taxon, including the unclassified populations occurring north of Texas, by way of an isozyme profile. We focused only on those variable loci for which abundant data were available: *Aat-1, Gpi-3, Idh-1, Idh-2, Idh-3, Mdh-2, Mdh-3, Pgm-6*. Alleles found rarely or as apparent introgressants in a taxon were not included in that taxon's isozyme profile. Introgressants were presumed based on heterozygous conditions such as those described in general terms, above, and more specifically, below.

## RESULTS

The frequencies of 40 alleles at 15 variable enzyme loci are presented in Table 3. All accessions were fixed for *Gpi-2l, Mdh-1c,* and *Pgm-1a*. Many other alleles were widespread across accessions and therefore uninformative (e.g., *G2d-1n, Idh-1e, Idh-2g, Lap-1f, Mdh-2i, Pgm-6v*).

TABLE 3.—Frequencies (expressed as percentages) of 40 alleles at 15 enzyme loci for 28 wild populations, eight cultivars, and four Mexican landraces of *Cucurbita pepo*.

| Locus | Aat-1 | | | Aat-3 | | Aat-4 | | | G2d-1 | | | G2d-2 | | Gpi-3 | | Idh-1 | | Idh-2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allele | *b* | *d* | *e* | *g* | *j* | *r* | *u* | *v* | *i* | *k* | *n* | *v* | $x^n$ | *o* | *u* | *b* | *e* | *g* | *m* |
| Wild populations: | | | | | | | | | | | | | | | | | | | |
| ?AR801 | 25 | 75 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ?AR802 | 0 | 45 | 55 | 0 | 100 | 86 | 14 | 0 | 5 | 0 | 95 | 100 | 0 | 0 | 100 | 0 | 100 | 55 | 45 |
| ?AR803 | 0 | 5 | 95 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 75 | 25 |
| ?AR804 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 94 | 6 |
| ?AR818 | 0 | 89 | 11 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 89 | 11 |
| ?AR819 | 0 | 39 | 61 | 0 | 100 | 100 | 0 | 0 | 11 | 0 | 89 | 100 | 0 | 0 | 100 | 0 | 100 | 33 | 67 |
| ?AR820 | 0 | 50 | 50 | 0 | 100 | 63 | 12 | 25 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 81 | 19 |
| ?IL812 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ?KY813 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 39 | 0 | 61 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ?LA811 | 0 | 100 | 0 | 0 | 100 | 88 | 12 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ?LA814 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 27 | 0 | 73 | 100 | 0 | 0 | 100 | 23 | 77 | 0 | 100 |
| ?MO808 | 0 | 44 | 56 | 0 | 100 | 89 | 11 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 67 | 33 |
| ?MO809 | 0 | 50 | 50 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 50 | 50 |
| ?MO810 | 0 | 40 | 60 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 80 | 20 |
| ?MO815 | 0 | 22 | 78 | 22 | 78 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 56 | 44 |
| ?MO816 | 15 | 58 | 27 | 8 | 92 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 65 | 35 |
| ?MO822 | 0 | 0 | 100 | 4 | 96 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 4 | 96 | 18 | 82 |
| ?OK805 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ?OK806 | 0 | 63 | 37 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 96 | 4 |
| ?OK807 | 0 | 44 | 56 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 88 | 12 |
| FRA750 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 15 | 85 | 100 | 0 | 35 | 65 | 20 | 80 | 100 | 0 |
| FRA751 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX747 | 0 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX779 | 0 | 0 | 100 | 0 | 100 | 88 | 12 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX780 | 0 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX781 | 0 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX782 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| TEX783 | 0 | 0 | 100 | 0 | 100 | 56 | 44 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| var. *ovifera:* | | | | | | | | | | | | | | | | | | | |
| FMA467 | 50 | 50 | 0 | 0 | 100 | 50 | 50 | 0 | 36 | 0 | 64 | 100 | 0 | 0 | 100 | 28 | 72 | 100 | 0 |
| OEN538 | 12 | 88 | 0 | 69 | 31 | 100 | 0 | 0 | 0 | 0 | 100 | 94 | 6 | 25 | 75 | 6 | 94 | 100 | 0 |
| OFS774 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 6 | 94 | 0 | 100 | 100 | 0 |
| OPS763 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 |
| ssp. *pepo:* | | | | | | | | | | | | | | | | | | | |
| OBO775 | 22 | 78 | 0 | 33 | 67 | 100 | 0 | 0 | 6 | 0 | 94 | 100 | 0 | 17 | 83 | 17 | 83 | 100 | 0 |
| OWO765 | 55 | 45 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 5 | 95 | 100 | 0 |
| PCO759 | 69 | 31 | 0 | 100 | 0 | 100 | 0 | 0 | 6 | 0 | 94 | 94 | 6 | 94 | 6 | 94 | 6 | 100 | 0 |
| PSU772 | 75 | 13 | 12 | 100 | 0 | 94 | 6 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 0 | 100 | 0 |
| XGU777 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 94 | 6 | 100 | 0 |
| XHU543 | 100 | 0 | 0 | 97 | 3 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 83 | 17 | 100 | 0 |
| XQU778 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 25 | 75 | 100 | 0 |
| XYU468 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 100 | 0 | 100 | 0 | 100 | 0 | 100 | 0 |

| Idh-3 | | Lap-1 | | | | Mdh-2 | | Mdh-3 | | | Pgm-5 | | Pgm-6 | | Skd-1 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *m* | *o* | *e* | *f* | *f*$^{n}$ | *g* | *e* | *i* | *m* | *q* | *u* | *n* | *o* | *s* | *v* | *g* | *h* | *l* | *k* | *m* | *p* |
| 100 | 0 | 0 | 100 | 0 | 0 | 85 | 15 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 18 | 82 | 14 | 86 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 5 | 0 | 95 | 0 |
| 100 | 0 | 0 | 85 | 0 | 15 | 25 | 75 | 5 | 95 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 37 | 63 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 37 | 0 | 63 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 28 | 72 | 11 | 89 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 89 | 0 | 11 | 33 | 67 | 61 | 39 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 72 | 28 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 25 | 75 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 37 | 0 | 63 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 20 | 80 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 56 | 44 | 56 | 0 | 44 | 0 | 100 | 50 | 50 | 0 | 0 | 100 | 0 | 0 | 0 |
| 44 | 56 | 0 | 56 | 44 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 6 | 0 | 94 | 0 |
| 85 | 15 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 44 | 56 | 11 | 89 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 22 | 0 | 78 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 50 | 50 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 75 | 0 | 25 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 30 | 0 | 70 | 0 |
| 100 | 0 | 0 | 83 | 17 | 0 | 17 | 83 | 0 | 72 | 28 | 0 | 100 | 17 | 83 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 8 | 92 | 0 | 0 | 4 | 96 | 0 | 77 | 23 | 0 | 100 | 0 | 100 | 4 | 0 | 0 | 0 | 96 | 0 |
| 100 | 0 | 0 | 96 | 0 | 4 | 100 | 0 | 82 | 18 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 4 | 0 | 96 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 4 | 96 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 6 | 0 | 0 | 0 | 94 | 0 |
| 100 | 0 | 0 | 40 | 0 | 60 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 90 | 10 | 0 | 0 | 0 | 100 | 0 | 0 |
| 100 | 0 | 0 | 61 | 0 | 39 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 6 | 94 | 0 | 0 | 0 | 100 | 0 | 0 |
| 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 0 |
| 12 | 88 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 0 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 0 | 0 | 100 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 0 | 100 | 0 | 9 | 91 | 0 | 100 | 0 | 0 | 0 | 6 | 94 | 0 |
| 100 | 0 | 19 | 62 | 0 | 19 | 44 | 56 | 38 | 6 | 56 | 0 | 100 | 14 | 86 | 50 | 0 | 0 | 0 | 50 | 0 |
| 100 | 0 | 0 | 81 | 0 | 19 | 0 | 100 | 37 | 44 | 19 | 0 | 100 | 6 | 94 | 0 | 0 | 19 | 0 | 81 | 0 |
| 100 | 0 | 0 | 88 | 0 | 12 | 100 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 56 | 0 | 44 | 0 |
| 100 | 0 | 0 | 17 | 0 | 83 | 0 | 100 | 89 | 11 | 0 | 0 | 100 | 94 | 6 | 100 | 0 | 0 | 0 | 0 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 25 | 5 | 70 | 10 | 90 | 100 | 0 | 75 | 0 | 0 | 75 | 0 | 0 |
| 100 | 0 | 19 | 6 | 0 | 75 | 0 | 100 | 0 | 25 | 75 | 0 | 100 | 81 | 19 | 69 | 0 | 13 | 12 | 6 | 0 |
| 100 | 0 | 50 | 0 | 0 | 50 | 19 | 81 | 0 | 0 | 100 | 0 | 100 | 75 | 25 | 38 | 0 | 6 | 37 | 19 | 0 |
| 100 | 0 | 0 | 50 | 0 | 50 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 75 | 0 | 0 | 0 | 25 | 0 |
| 100 | 0 | 73 | 0 | 0 | 27 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 83 | 17 | 22 | 11 | 0 | 0 | 67 | 0 |
| 100 | 0 | 0 | 0 | 0 | 100 | 0 | 100 | 0 | 0 | 100 | 0 | 100 | 100 | 0 | 94 | 0 | 0 | 0 | 6 | 0 |
| 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 | 100 | 100 | 0 | 0 | 100 | 0 | 0 | 0 | 100 | 0 | 0 |

Some alleles indicated a genetic link between populations in Texas and those farther north. As noted in an earlier study (Decker and Wilson 1987), *Idh-3o* is an allele that characterizes var. *texana* (Table 3; Fig. 2). It has never been found in any cultivar or landrace of var. *ovifera* or ssp. *pepo* (Table 3; Decker 1986; Wilson 1989). However, this allele was detected in both populations from Louisiana (Table 3) and in a population from southwestern Arkansas (Fig. 2; Decker and Wilson 1987). The allele *Aat-1e*⁻ exhibited a similar pattern; it characterizes populations of var. *texana*, is rare in domesticated material (Decker 1986), and was found in several of the populations north of Texas (Fig. 3). In fact, three non-Texas populations (?AR801, ?MO822, ?OK805) were fixed for *Aat-1e*⁻ (Table 3; Fig. 3). Another allele linking Texas populations to those farther north is *Aat-4u* (Table 3). We found this allele in all but one Texas population, in five populations to the north (?AR802, ?AR820, ?IL812, ?LA811, ?MO808), and in two cultivars (FMA467, PSU772). However, since only cultivars in this study have been tested for variation at *Aat-4*, the distribution of allele "*u*" in domesticated material in general cannot yet be determined.

Within *C. pepo*, a few alleles, including *Aat-4v*⁻, *Idh-2m*, and *Lap-1f*ⁿ, were unique to populations north of Texas (Table 3). Of these, only *Idh-2m* was widespread, characterizing populations in Arkansas, Missouri, and northwestern Louisiana (Fig. 4). This allele, which was interpreted by Wilson (1989) as a null or inactive variant, appears to occur as a dominant allele in *C. argyrosperma* as well (Decker 1986; Decker-Walters et al. 1990; Wilson 1989). If introgression from *C. argyrosperma* accounted for the widespread presence of *Idh-2m* in populations of *C. pepo*, then we should have found other alleles characteristic of *C. argyrosperma* (e.g., *Gpi-3o, Lap-1c, Skd-1s;* Decker-Walters et al. 1990) in at least a few of these populations; we did not (Table 3). Remaining possible explanations are that *Idh-2m* was either present in the shared ancestor of these two species or had separate origins in these species or their ancestors. The latter interpretation would be supported if *Idh-2m* were a null allele. In either case, these scenarios indicate that many of the wild populations north of Texas could not be cultivar escapes since this allele has not been found in cultivars of *C. pepo*.

Table 3 quickly reveals that the unclassified northern populations exhibited greater genetic affinities to ssp. *ovifera* and ssp. *fraterna* than to ssp. *pepo*. Inasmuch as previous isozyme, morphological, and DNA studies (Decker 1986, 1988; Wilson et al. 1992) already indicated that ssp. *pepo* has followed a distinct evolutionary path, alleles that characterized ssp. *pepo* and occurred in few wild populations, usually as one or two heterozygous individuals, were assessed as cultivar introgressants in those populations; these include *Aat-1b, Aat-3g, Idh-1b, Lap-1e, Mdh-3u, Pgm-6s,* and *Skd-1g* (Table 3). Using these alleles as markers, we detected first-generation hybridization resulting from cultivar pollen on wild stigmas in ?AR803, ?LA814, ?MO822, and ?OK807. For example, the genetic configuration of one individual in ?MO822 included *Aat-3gj, Idh-1be*⁻, *Lap-1fg,* and *Skdj-1im,* whereas the remaining individuals, including another from the same fruit, were homozygous at these loci for the alleles commonly found in the northern populations (*Aat-3jj, Idh-1e*⁻*e*⁻, *Lap-1ff, Skd-1mm*). In a previous study (Decker and Wilson 1987), similar evidence, in the form of heterozygous progeny, was discovered for populations in Alabama, Illinois, and even Texas. In the more recently surveyed populations, a longer history of gene flow, as suggested by a few individuals homozygous for alleles listed above, was evident in ?AR801, ?AR819, ?MO815, and ?MO816. In

TABLE 4.—Isozyme profiles for taxa of *Cucurbita pepo* and *C. argyrosperma* spp. *sororia*. Data from other sources (e.g., Decker 1986; Wilson 1989) were considered also. Acorn cultivars were not included in *C. pepo* spp. *ovifera* var. *ovifera*, whereas ssp. *pepo* was represented by Mexican landraces only.

| | Aat-1 | Gpi-3 | Idh-1 | Idh-2 | Idh-3 | Mdh-2 | Mdh-3 | Pgm-6 |
|---|---|---|---|---|---|---|---|---|
| *C. pepo* | | | | | | | | |
| var. *ovifera* | d | u | $e^-$ | g | m | e i | m q u | v |
| northern populations | d $e^-$ | u | $e^-$ | g m | m | e i | m q | v |
| var. *texana* | $e^-$ | u | $e^-$ | g | m o | i | q | v |
| ssp. *fraterna* | d | o u | b $e^-$ | g | m | i | q | s v |
| ssp. *pepo* | b | o | b $e^-$ | g | m | i | u | s v |
| *C. argyrosperma* | | | | | | | | |
| ssp. *sororia* | $e^-$ | o | $e^-$ | g m | m | i | q | v |

TABLE 5.—Nei's (1972) genetic identity values (percentages) calculated for *C. pepo* ssp. *ovifera* var. *ovifera*, ssp. *ovifera* var. *texana*, ssp. *fraterna*, spp. *pepo*, and unclassified northern populations.

| Taxon | O | ? | T | F | P |
|---|---|---|---|---|---|
| var. *ovifera* (O) | 89 | | | | |
| northern populations (?) | 89 | 93 | | | |
| var. *texana* (T) | 79 | 86 | 92 | | |
| ssp. *fraterna* (F) | 84 | 85 | 76 | 95 | |
| ssp. *pepo* (P) | 68 | 64 | 56 | 71 | 87 |

?MO816, for example, one individual was homozygous for *Lap-1ee* and *Mdh-3uu* and heterozygous for *Aat-1bd*. In each of these cases the putative introgressant alleles occurred within the population at a frequency less than 30% (Table 3) except for ?KY813, which had high frequencies of *Mdh-3u* (44%) and *Pgm-6s* (50%), suggesting that this fruit may have come from a feral domesticated plant.

One allele that was surprisingly missing from northern populations was *Gpi-3o*. This allele, which is dominant in ssp. *pepo* cultivars (Table 4; Decker 1986, 1988), would be expected to occur in wild populations if cultivar introgression were common, unless selection in the wild acted to remove this allele, probably as the result of linkage to a morphological or ecological character.

One reason why foreign alleles were easily recognizable is because most of the populations north of Texas possessed a unique and largely coherent genetic profile (Table 4). This profile is most like that of the ssp. *ovifera* var. *ovifera* lineage of cultivars, with some similarity to var. *texana* and ssp. *fraterna* as well (Table 4).

These profiles along with the genetic identity values (Table 5) suggest relationships among the other taxa. The taxon most genetically similar to the ssp. *pepo* lineage is ssp. *fraterna* (Table 5). However, there are significant differences between these taxa at *Aat-1* and *Mdh-3* (Table 4), and ssp. *fraterna* exhibits larger genetic identity values with ssp. *ovifera* than it does with ssp. *pepo* (Table 5).

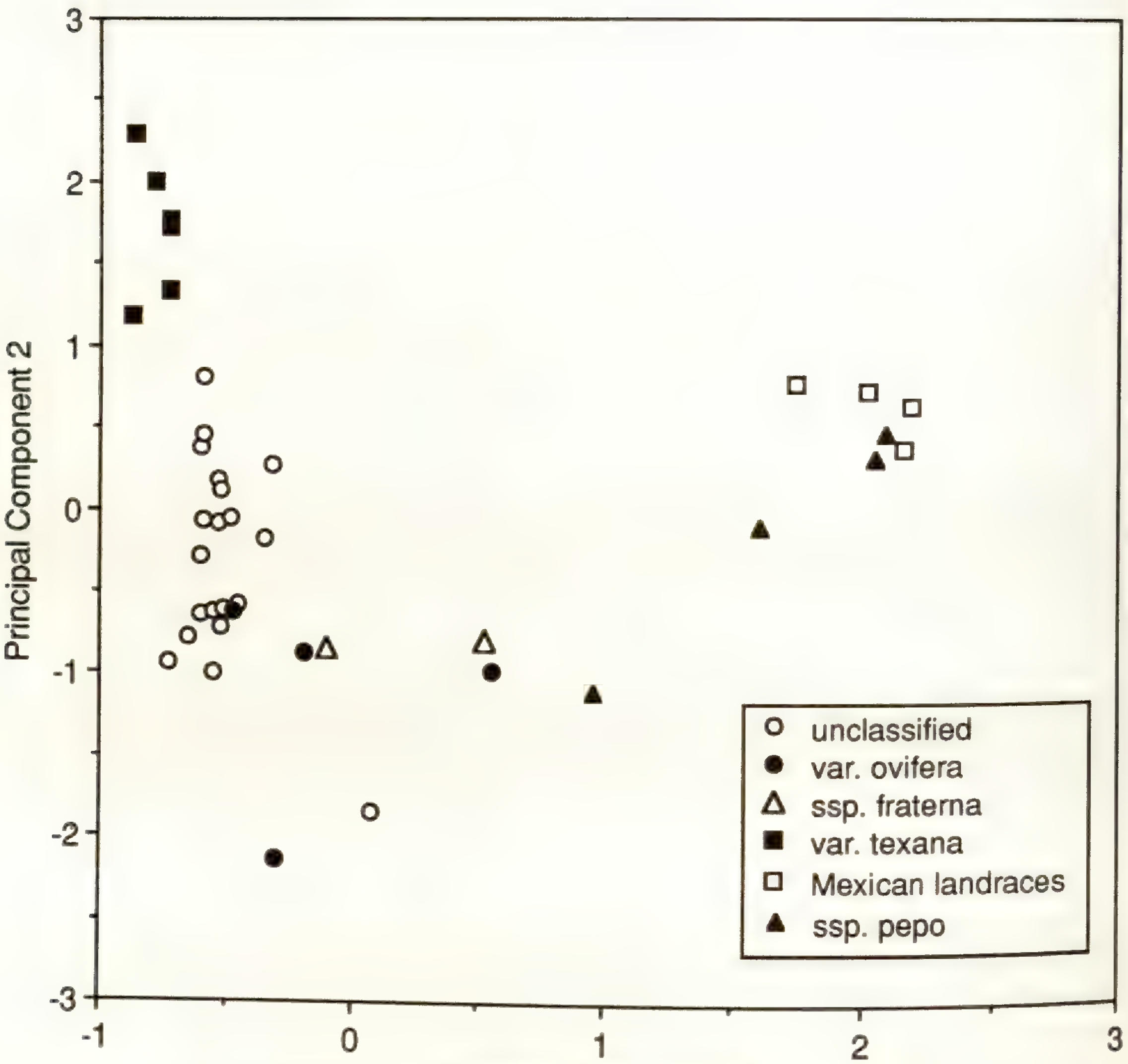


FIG. 5.—Plot of the first two principal components in the analysis of 20 unclassified populations of *Cucurbita pepo,* four cultivars of ssp. *ovifera* var. *ovifera,* two populations of ssp. *fraterna,* six populations of ssp. *ovifera* var. *texana,* and four Mexican landraces and four cultivars of ssp. *pepo.*

Taxon relationships are also revealed in the plotted results of the principal component analyses (Figs. 5 and 6). In the first analysis (Fig. 5), which included all accessions, the first component (PC1), accounting for 47% of the total variation, served to distinguish cultivars and Mexican landraces of ssp. *pepo.* Among members of ssp. *pepo* only 'Orange Ball' had a relatively low value for PC1 (0.963), placing it near 'Nest Egg' (PC1 = 0.560) and one of the populations of ssp. *fraterna* (PC1 = 0.527). Populations of ssp. *ovifera* var. *texana* were pulled away from other accessions by having high values for PC2, which accounted for 13% of the total variation. The unclassified northern populations clustered more or less together, except for the accession from Kentucky (PC2 = –1.839). 'Striped Pear' also had a low value for PC2 (–2.143), whereas 'Mandan' clustered with the northern populations and 'Flat Striped' occurred very close to one of the populations of ssp. *fraterna.*

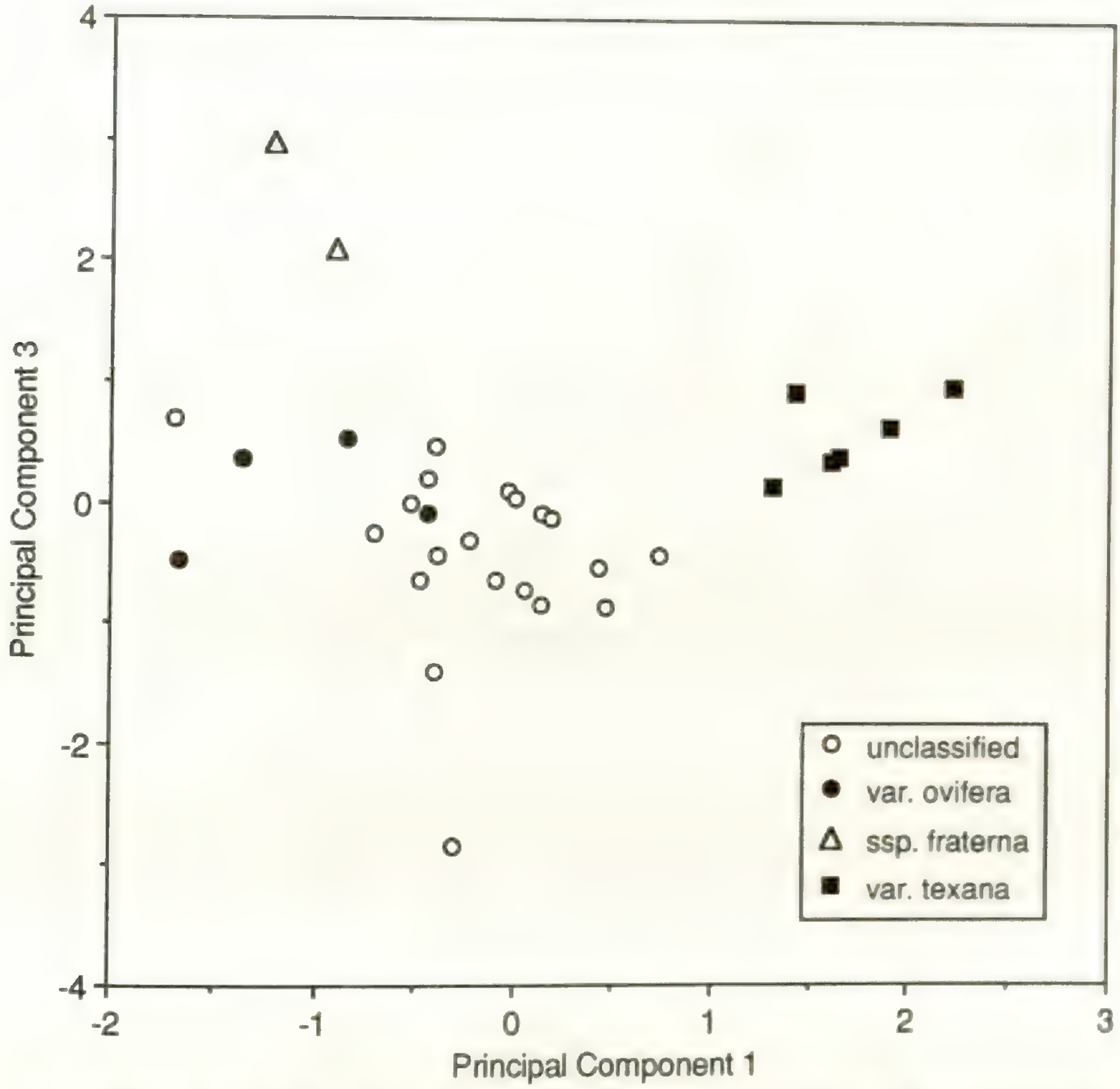


FIG. 6.—Plot of the first and third principal components in the analysis of 20 unclassified populations of *Cucurbita pepo,* four cultivars of ssp. *ovifera* var. *ovifera,* two populations of ssp. *fraterna,* and six populations of ssp. *ovifera* var. *texana.*

To further clarify the genetic affinities of domesticated ssp. *ovifera,* principal component analysis was performed after excluding domesticated ssp. *pepo* (Fig. 6). Along PC1, accounting for 30% of the total variation in this analysis, populations of ssp. *ovifera* var. *texana* were once again distinguished from remaining accessions. No distinct groupings were revealed by PC2 (not shown), which accounted for 20% of the total variation. Populations of ssp. *fraterna* had high values for PC3, which accounted for 14% of the total variation (Fig. 6). Once again, 'Mandan' clustered with the bulk of northern populations. Lower PC1 values were seen in 'Flat Striped' (PC1 = -0.850), 'Nest Egg' (-1.362), 'Striped Pear' (-1.663), and the fruit from Kentucky (-1.689). ?MO822 displayed the lowest value for PC3 (Fig. 6).

In summary, the principal component analyses revealed the following genetic affinity groupings in descending order of distinctiveness: ssp. *pepo,* ssp. *ovifera* var. *texana,* and ssp. *fraterna.* Although, as a group, cultivars of ssp. *ovifera* var. *ovifera* did not appear to cluster randomly among the northern populations, neither were they completely separated from these populations as a distinct grouping (Figs. 5 and 6).

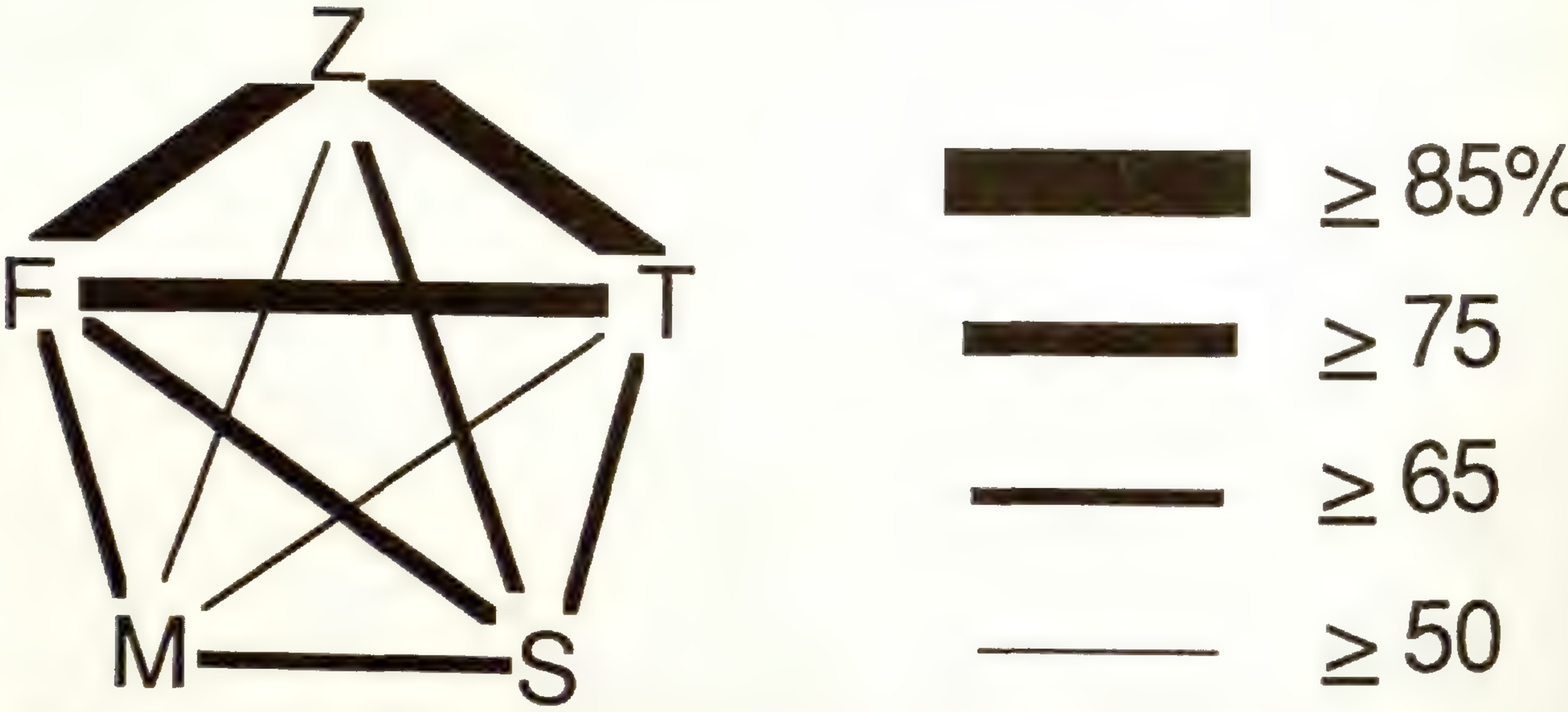


FIG. 7.—Nei's (1972) genetic identity values among *Cucurbita pepo* ssp. *fraterna* (F), Mexican landraces of ssp. *pepo* (M), ssp. *ovifera* var. *texana* (T), *C. argyrosperma* ssp. *sororia* (S), and unclassified northern populations (Z).

Previous phylogenetic analysis (Decker-Walters et al. 1990) indicates that the isozyme profile of *C. argyrosperma* ssp. *sororia* (Table 4) contains mostly symplesiomorphic (having originated in an earlier ancestor) alleles that are shared with *C. pepo*. In fact, the only uncertainties in this regard are *Idh-2m*, which was discussed earlier, and alleles at *Aat-1*. Consequently, differences between *C. argyrosperma* ssp. *sororia* and various groups of *C. pepo* are due primarily to derived character states in *C. pepo* (Table 4). Neither the profiles nor the genetic identity values (Fig. 7) suggest that *C. argyrosperma* ssp. *sororia* exhibits a closer relationship to one *C. pepo* taxon than it does to the other *C. pepo* taxa. In other words, divergence of each *C. pepo* taxon from the common ancestor of *C. argyrosperma* spp. *sororia* and *C. pepo* has occurred at very similar rates. Interestingly, genetic divergence between Mexican landraces of ssp. *pepo* and wild U.S. populations is greater than that between *C. argyrosperma* ssp. *sororia* and taxa of *C. pepo* (Fig. 7).

## DISCUSSION

*The status of northern populations.*—As a group, wild populations of *C. pepo* north of Texas possessed a distinct though variable genetic profile, which usually included *Idh-2m* and the ssp. *ovifera* var. *texana* allele, *Aat-1e*. Louisiana and Arkansas populations close to Texas also exhibited an allele otherwise restricted to var. *texana*, *Idh-3o*. The overall isozyme profile and these alleles in particular are evidence that populations north of Texas developed their own genetic identity, probably over a long period of relative isolation.

The northern populations display close isozyme affinities to cultivars of var. *ovifera*, var. *texana*, and ssp. *fraterna*. However, morphologically and ecologically ssp. *fraterna* is distinct from the remaining wild populations (Andres 1987). For example, mature fruits of ssp. *fraterna* turn yellow-orange whereas those of var. *texana* and the more northern populations do not. Also, ssp. *fraterna* seeds are relatively slow to germinate (within 5–15 days) and the plants are found in upland

habitats as opposed to the riparian habitats characterizing var. *texana* and populations to the north (i.e., Cowan and Smith, this volume). On the bases of fruit characters and ecogeography, we recognize wild populations north of Texas as more closely related to var. *texana* than to ssp. *fraterna*. Furthermore, ecogeographic, fruit structure, and allozyme data indicate that these populations can be circumscribed as a distinct variety of ssp. *ovifera*, as described below. The circumscription of var. *texana* is changed from Decker (1988) to include Texas populations only.

Key to the Varieties of *Cucurbita pepo* ssp. *ovifera*:

1. Fruit almost always bitter, solid ivory or green- and white-striped but never yellow or orange, rind smooth; seed germination within 1–7 days; possessing *Idh-2m* and/or *Idh-3o;* wild.
   2. Fruit typically solid ivory; germination within 1–4 days; possessing *Idh-2m,* may possess *Idh-3o;* Illinois, Missouri, Arkansas, Oklahoma, Louisiana. var. *ozarkana*
   2. Fruit typically green- and white-striped; germination within 3–7 days; possessing *Idh-3o,* lacking *Idh-2m;* Texas. var. *texana*
1. Fruit non-bitter (except for some ornamental gourd cultivars), solid or striped, in a variety of colors including yellow and orange, rind smooth, ribbed, or warted; germination within 3–15 days depending on the cultivar; lacking *Idh-2m* and *Idh-3o;* under cultivation. var. *ovifera*

**Cucurbita pepo** L. ssp. **ovifera** (L.) Decker var. **ozarkana** Decker-Walters, var. nov., OZARK GOURD.—TYPE: USA, Arkansas, Independence County, Nov 6, 1990, *B. Smith & W. Cowan 115* (holotype: US!).

A var. *ovifera* atque var. *texana* allele *m* ad locu *Idh-2* e isocitrate dehydrogenase et germinatione praecoci seminum, a var. *texana* fructibus eburneis differt. (Author's translation: Is distinguished from var. *ovifera* and var. *tenana* by allele *m* at locus *Idh-2* of isocitrate dehydrogenase and early seed germination, is distinguished from var. *texana* by having ivory fruits).

Morphology. (Only fruits and seeds have been studied in any detail [see Smith et al. 1992; Cowan and Smith, this volume].) Mature fruits of *C. pepo* ssp. *ovifera* var. *ozarkana* are bitter, ivory or rarely green- and white-striped, oblate to round to prolate to pyriform, and measure 3.2–4.6 cm in diameter and 3.9–10.0 cm in height. Rinds are thin, measuring 0.8–2.2 mm in thickness, and smooth. Peduncles measure 5.3–8.6 mm in diameter at their base. Seeds are 7.8–10.1 mm long and 5.2–6.7 mm wide. Deviations from these character states have been interpreted as evidence of cultivar introgression (Cowan and Smith, this volume).

Isozymes. This variety is distinguished from other varieties of ssp. *ovifera* by possession of the isozyme allele *Idh-2m*. Populations of var. *ozarkana* are further characterized by the alleles *Aat-1d* and/or *-1e*, *- 3j*, *-4r* and/or *-4u; G2d-1k*, *-2v; Gpi-3u; Idh-1e*, *-2g*, *-3m; Lap-1f; Mdh-2e* and/or *-2i*, *-3m* and/or *-3q; Pgm-5o*, *-6v;*

and *Skd-1i* and/or *-1m*. *Aat-3v*, *G2d-1i*, *Idh-3o*, and *Lap-1f*[1] are relatively rare alleles found in some populations.

Distribution and ecology. Populations of var. *ozarkana* have been discovered in western Illinois, southern Missouri, Arkansas, eastern Oklahoma, and Louisiana. This taxon's distribution may include similar populations in Kentucky and Alabama. Populations appear most abundant along rivers and streams draining the Ozark Plateau and the Ouachita Mountains. The plants are adapted to the naturally disturbed areas in riverine floodplains and can invade humanly disturbed habitats as well. Fruits are water-dispersed. This variety is distinguished from other varieties of ssp. *ovifera* by the relatively quick seed germination (usually within two days). The distribution and ecology of var. *ozarkana* are described more fully in Smith et al. (1992).

Deviating most from the typical var. *ozarkana* isozyme and morphological profiles were populations at the northern and eastern extremes of the range as we know it, in Kentucky, Illinois, and Alabama. Of these, the most likely candidate for a purely feral population was that represented by the fruit from Kentucky. We consider the evolutionary status of the Alabama populations to be uncertain.

*Evolutionary trends in C. pepo.*—Because previous genetic work (Decker 1988; Wilson et al. 1992) had already shown that cultivars of ssp. *ovifera* and ssp. *pepo* were derived from genetically divergent population lineages, it was relatively easy to detect and assess as introgressants in wild populations of ssp. *ovifera* those alleles that were otherwise restricted to and characterized ssp. *pepo*. First-generation gene flow from cultivars to wild populations was detected in several populations of var. *ozarkana* and in at least one population of var. *texana* (Decker and Wilson 1987). Although recent introgression is suggested by various other populations, the significance and temporal depth of hybridization between cultivars and wild populations is unclear. Obviously, introgression into the wild has not occurred to the extent of obliterating a more ancient genetic background in var. *ozarkana*.

Evolutionary relationships among taxa of *C. pepo* are indicated by the isozyme data. Most, if not all, primitive cultivars of var. *ovifera* apparently have their origins in var. *ozarkana*. Variety *ozarkana* possesses the isozyme patterns typical of a wild progenitor of a crop: isozyme alleles in the crop (i.e., var. *ovifera*) are generally a subset of those in the progenitor (i.e., var. *ozarkana*) and the two taxa are genetically similar, usually with a genetic identity value of 0.90 or greater (cf. Doebley 1989). The fact that Doebley's (1989) extensive survey of isozyme variation in crops and their putative progenitors yielded the "subset" criterion says the following about the effects of domestication on isozyme variation: few, if any, new alleles are introduced as a result of human intervention. This is why it was concluded previously (i.e., Decker 1988) that domesticated members of ssp. *pepo* and ssp. *ovifera* were selected from genetically diverged wild populations already exhibiting the distinct alleles found in these subspecies today.

Although ssp. *fraterna* has a genetic identity value with ssp. *ovifera* var. *ovifera* that is also close to 0.90, ssp. *fraterna* apparently lacks at least three alleles (*Mdh-2e, Mdh-3m, Skd-1m*) that are in high frequencies in cultivars of ssp. *ovifera;* hence ssp. *fraterna* fails the first criterion wherein alleles of the crop are a subset of those in the

wild progenitor. Nevertheless, the principal component analyses did indicate close overall genetic affinities between a few cultivars that have been classified under ssp. *ovifera* var. *ovifera* (i.e., 'Flat Striped') and ssp. *pepo* (i.e., 'Orange Ball'), indicating that at least some cultivars may have been selected from populations in northeastern Mexico (cf. Andres 1987). Further study of ssp. *fraterna* is needed to make these determinations.

Most analyses revealed a relatively distinct isozyme pattern for ssp. *ovifera* var. *texana*. Like ssp. *fraterna,* Texas populations lack various alleles common in ssp. *ovifera* var. *ovifera*. In addition, almost all populations of var. *texana* contain an allele (*Idh-3o*) not found in any cultivars. Consequently, evidence is lacking which would suggest that any cultivar or group of cultivars have their direct origins in Texas populations.

Applying Doebley's (1989) criteria in search of the wild ancestor of Mexican landraces of ssp. *pepo,* we do not find a good candidate for progenitor among currently known wild populations. Consequently, we believe that populations of this wild progenitor are undiscovered or probably extinct. Furthermore, the pat tern of genetic differentiation (as discussed below) between ssp. *pepo* and the other taxa, including the Mexican ssp. *fraterna,* suggests that the progenitor of ssp. *pepo* evolved in a distinct area of Mexico.

Examination of *C. argyrosperma* ssp. *sororia* gave us an additional evolutionary perspective on isozyme variation of *C. pepo*. The fact that *C. argyrosperma* ssp. *sororia* exhibited more or less equally divergent but genetically distinct relationships with each taxon of *C. pepo* indicates that long periods of reproductive isolation due to geographic separation probably account for differences among ssp. *ovifera* var. *ozarkana,* var. *texana,* ssp. *fraterna,* and the hypothesized progenitor of ssp. *pepo*. Such a conclusion fits Wiley's model of vicariance speciation in which geographically disjunct progenitor populations are replaced by more divergent and genetically different populations through time (Wiley 1981; Wiley and Mayden 1985). This means that none of the wild populations known today is genetically equivalent to what were the most ancient populations of *C. pepo*. This interpretation of geographic divergence requires fewer *ad hoc* assumptions than in presuming that a mixture of other factors (e.g., selection) produced this pattern of uniform divergence among taxa of *C. pepo*. Of course, what requires the fewest assumptions does not necessarily reflect reality and factors such as human and natural selection (e.g., seed germination rates) and population bottlenecks (e.g., relative genetic homogeneity in ssp. *ovifera* var. *texana*) have undoubtedly contributed to the genetic patterns we see today. With those possibilities in mind, we speculate that the original distribution of wild populations of *Cucurbita pepo,* which ranged from central or southern Mexico north, at least to the Ozark Plateau, and east, possibly as far as Florida (Decker and Newsom 1988; Newsom et al., this volume), became dissected long before at least two independent domestications took place.

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# BOOK REVIEW

**The Origins of Southwestern Agriculture.** R.G. Matson. Tucson and London: University of Arizona Press, 1991. $60.00 (clothbound). Pp. xv, 356. ISBN 0-8165-1196-9.

This is a well written, organized, researched and documented book, based on the author's own work and reports and publications of others. It is profusely illustrated and there are eight tables of data. I wish I could offer as much praise for the index, which I found disappointing in that it is largely a listing of names of investigators and archaeological sites and locations. Beans and squash, both cultivated, are mentioned in a few places in the text, but neither is in the index under either common or generic names.

As a general ethnobotanist with only some exposure to archaeological ethnobotany, I was unfamiliar with the author and his research. Given the title of the book, imagine my dismay when, upon glancing through it, I discovered that most of the illustrations related to archaeology: diagrams of excavations, locations, and projectile points. My immediate reaction was to question the relevance of what appeared to be a superfluidity of archaeological data, discussion, argument, and interpretation. Although I have now read the book and see the connection, I must alert readers of this journal that they are likely to find the perspective on the origins of agriculture in this book to be dissimilar from that found in treatises on the subject stemming from a largely biological point of view.

After three chapters, covering over 200 pages, (Introduction; The nature of Basketmaker II; and The nature of the Plateau Archaic), the author discusses maize in 74 pages of text in chapters 4, 5, and 6: The evolutionary model of maize use; The age of maize in the Southwest; and The three models and the age of maize. Herein, Matson also discusses and "tests" these models against the available archaeological data from various regions of the southwestern U.S.A. This is a solid, scholarly approach to the subject and the material in these critical chapters is well integrated with that in earlier and later sections.

Judging from the title of the book, one might assume that other cultivated plants would be given recognition. But the facts of life are that these other species are often only poorly represented in archaeological sites (e.g. seeds of beans do not preserve well) thus making developmental models difficult if not impossible for construction, to say nothing of "testing."

While recognizing that the author wrote primarily for archaeological scholars, I find, as an ethnobotanist, the book's title misleading. Nevertheless, because of my interest in and familiarity with the Southwest, the extensive archaeological treatment was interesting and valuable to me and I recommend Matson's book to those who are working in southwestern ethnobotany, even to those whose studies do not focus primarily upon looking back through time.

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*Journal of Ethnobiology*
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# HISTORY AND GEOGRAPHIC DISTRIBUTION OF *Cucurbita pepo* GOURDS IN FLORIDA

LEE A. NEWSOM
S. DAVID WEBB
*Florida Museum of Natural History*
*Museum Road*
*Gainesville, FL 32611*

JAMES S. DUNBAR
*Florida Bureau of Archaeological Research*
*R.A. Gray Building*
*Tallahassee, FL 32399–0250*

ABSTRACT.—Page-Ladson, a Florida wet site, has yielded *Cucurbita pepo* gourd seeds that date to the Pleistocene-Holocene transition. One sample with gourd seeds has accelerator radiocarbon dates of 12,545 ± 80 B.P. and 12,375 ± 75 B.P. (NSF-Arizona AMS lab, AA-7452 AA-7453). A gourd seed from a deeper stratum was directly dated by the accelerator method to 12,570 ± 100 B.P. (AA-8759). These records constitute the earliest for the genus *Cucurbita* from any geographic area. The Page-Ladson seeds and *Cucurbita pepo* remains from other Florida wet sites are compared; morphometric data from the combined collections indicate that all prehistoric seeds from Florida appear to be from wild gourd populations. The implications of recovering Pleistocene gourds in eastern North America are discussed, and a revised interpretation of their prehistoric distribution and cultural significance is presented.

RESUMEN.—Page-Ladson, un sitio arqueológico pantanoso en la Florida, ha proporcionado semillas del calabazo *Cucurbita pepo* que datan de la transición del pleistoceno-holoceno. Una muestra que contiene semillas de calabazo ha sido datada, a partir de carbono radiactivo mediante acelerador, a 12,545 ± 80 y 12,375 ± 75 años antes del presente (AA-7452 y AA-7453, laboratorio AMS en Arizona de la Fundación Nacional de Ciencia de los Estados Unidos de Norteamérica). Una semilla de calabazo de un estrato más profundo fue datada directamente mediante el método del acelerador a 12,570 ± 100 años antes del presente. Estos constituyen los registros más tempranos para el género en cualquier área geográfica. Se comparan las semillas de Page-Ladson y los restos de *Cucurbita pepo* de otros sitios cenagosos de la Florida; los datos morfométricos de las colecciones combinadas indican que todas las semillas prehistóricas de la Florida parecen ser de poblaciones silvestres de calabazos. Se discuten las implicaciones de los calabazos del pleistoceno en Norteamérica oriental, y se presenta una interpretación actualizada de su distribución prehistórica y su importancia cultural.

RÉSUMÉ.—Page-Ladson, un site humide de Floride, a produit des graines de courges *Cucurbita pepo* qui datent de la transition Pleistocène-Holocène. Un échantillon comprenant des graines de courges a produit des dates basées sur

l'accélérateur radiocarbone de 12,545 ± 80 et 12,375 ± 75 années avant le présent (NSF-Arizona AMS lab, AA-7452, AA-7453). Une graine de courge provenant d'une couche plus profonde est datée directement par la méthode d'accélerateur à 12,570 ± 100 (AA-8759). Ce sont les données les plus anciennes pour le genre, quelque soit la region. Les graines de Page-Ladson et les restes de *Cucurbita pepo* provenant d'autres sites humides de Floride sont comparés; des données morphométriques obtenues sur les collections combinées indiquent que toutes les graines préhistoriques de Floride semblent provenir de populations de courges sauvages. Une discussion concernant les implications presentées par la présence de courges datant du Pleistocene dans l'est de l'Amérique du Nord est inclue, ainsi qu'une révision de l'interprétation de leur répartition préhistorique et de leur valeur culturelle.

## INTRODUCTION

Florida's wet sites are famous for their exceptional preservation of soft organic materials, including human brain tissue, woven fabric, wooden artifacts, and abundant plant structures (Coles and Coles 1989; Doran and Dickel 1988; MacDonald and Purdy 1982; Purdy 1988, 1991). Gourd remains, including bottle gourd *(Lagenaria siceraria)* and *Cucurbita* gourd *(Cucurbita pepo),* have been recovered from waterlogged deposits at several Florida sites. *Cucurbita* seeds and rind are known also from a few terrestrial excavations. Previously reported Florida archaeological contexts with *Cucurbita* gourds and other Cucurbitaceae range in age from at least 7000 years ago through the Spanish Mission Period that ended in the eighteenth century (Cutler 1975; Decker and Newsom 1988; Denson et al. 1992; Doran et al. 1990; Milanich and Fairbanks 1980:118; Mitchem and Hutchinson 1987; Newsom 1987, 1991, 1993; Newsom and Decker 1986; Newsom and Quitmyer 1992; Russo et al. 1992; Scarry 1985, 1991a, 1991b; Scarry and Newsom 1992).

Recent excavations at the Page-Ladson (8Je591) Site in the lower Aucilla River add another to the list of Florida sites with *Cucurbita* gourd remains. Deposits at Page-Ladson range in date from the Wisconsin glacial maximum, approximately 18,000 years ago, to around 4000 B.P. Lithic, bone, and wooden artifacts from the late PaleoIndian and Archaic periods appear in terminal Pleistocene, early Holocene, and more recent strata (Dunbar et al. 1990).

*Cucurbita pepo* seeds were recovered from a series of strata encountered in separate excavation units at Page-Ladson. These strata also contain extinct Pleistocene megafauna, including horses (*Equus* sp.) and American mastodon *(Mammut americanum).* Evidence of human activity from some of the same general strata is present, but scant. One sample (F.S. 131) with gourd seeds has accelerator radiocarbon dates of 12,545 ± 80 B.P. and 12,375 ± 75 B.P. (NSF-Arizona AMS lab, AA-7452, AA-7453). A *Cucurbita* seed from the deepest excavation level (level 26B) of Test F was directly dated by the accelerator method, producing a date of 12,570 ± 100 B.P. (NSF-Arizona AMS lab AA-8759). With one exception, *Cucurbita pepo* seeds have currently not been documented in more recent Holocene-aged deposits at Page-Ladson.

In this paper we describe the Page-Ladson *Cucurbita pepo* seeds and the depositional contexts from which they were recovered. The Page-Ladson seeds are then compared with *Cucurbita pepo* seeds from other archaeological localities in Florida.

We outline a reconstruction of the antiquity and geographic distribution of *Cucurbita pepo* in Florida, incorporating the new data. We employ a biogeographic perspective to explain the Pleistocene *Cucurbita* gourd occurrence in the eastern United States. Finally, we discuss the hypothesis formulated by Smith et al. (1992) and others that an indigenous, eastern wild *Cucurbita* gourd was present in North America as early or earlier than archaeologically-documented Mesoamerican relatives as a new way to elucidate the controversial history of gourd use in North America.

## PAGE-LADSON (8JE591)

*Location and riverine environment.*—The Page-Ladson site occurs below the surface of the Aucilla River in a section of the river known as Half-Mile Rise (Fig. 1). Like most of the lower Aucilla River, Half-Mile Rise consists of a string of deeper segments representing sediment-filled sinkholes connected by shallower links; the river rises from one sinkhole, courses half a mile, and then disappears into another sinkhole. The site is located within one of the large, partly eroded sinkhole depressions.

Many features of the Page-Ladson site derive from its history as a coastal sinkhole in limestone (karst) terrain during the late glacial rise of sea level (Brooks 1967; Vernon 1951). During the late Pleistocene, backfilling sinkholes appeared as deep, isolated freshwater ponds (cenotes) surrounded by well-drained limestone terrain. Under the more arid conditions of the late Pleistocene in Florida (Watts and Hansen 1988), sinkhole ponds were an important source of fresh water.

Flowing water has removed large volumes of sediment from sinkholes in the river course and also has destroyed some of their defining limestone walls. Fortunately, the relatively deep erosion of the river channel through the sediments of the main sinkhole at Page-Ladson did not remove the portion along the west bank, where more than five meters of sediments record the late Pleistocene and early Holocene history of the area.

*Page-Ladson deposition and gourd-bearing contexts.*—Nine excavations of various proportions have been conducted at Page-Ladson, beginning in 1983. Excavation units that penetrate deeply enough reach a discontinuous, late Pleistocene reddish-brown peat stratum. Near the center of the main Page-Ladson sinkhole we encountered the oldest sediments consisting of buried peat that produced a radiocarbon date of 18,430 $\pm$ 220 B.P. (Dunbar et al. 1990). The next units encountered are 0.5–1.0m thick calcareous sand lenses that overlie and intergrade with the red-brown peat.

The red-brown peat and the associated calcarenite deposits frequently contain late Pleistocene vertebrates. During the most recent excavation at Page-Ladson (1991 Test F, Level 26B) a proboscidean (mastodon, mammoth) skull was uncovered with its tusks and lower portions buried in the red-brown peat and the cranium extending into the overlying calcareous sand. One *Cucurbita pepo* seed was found in the red-brown peat that filled the eye orbit of the skull. This particular gourd seed was dated by the accelerator radiocarbon method; the resulting date of 12,570 $\pm$ 100 B.P. (AA-8750) was mentioned earlier. This seed establishes the earliest date for *Cucurbita pepo* at Page-Ladson.

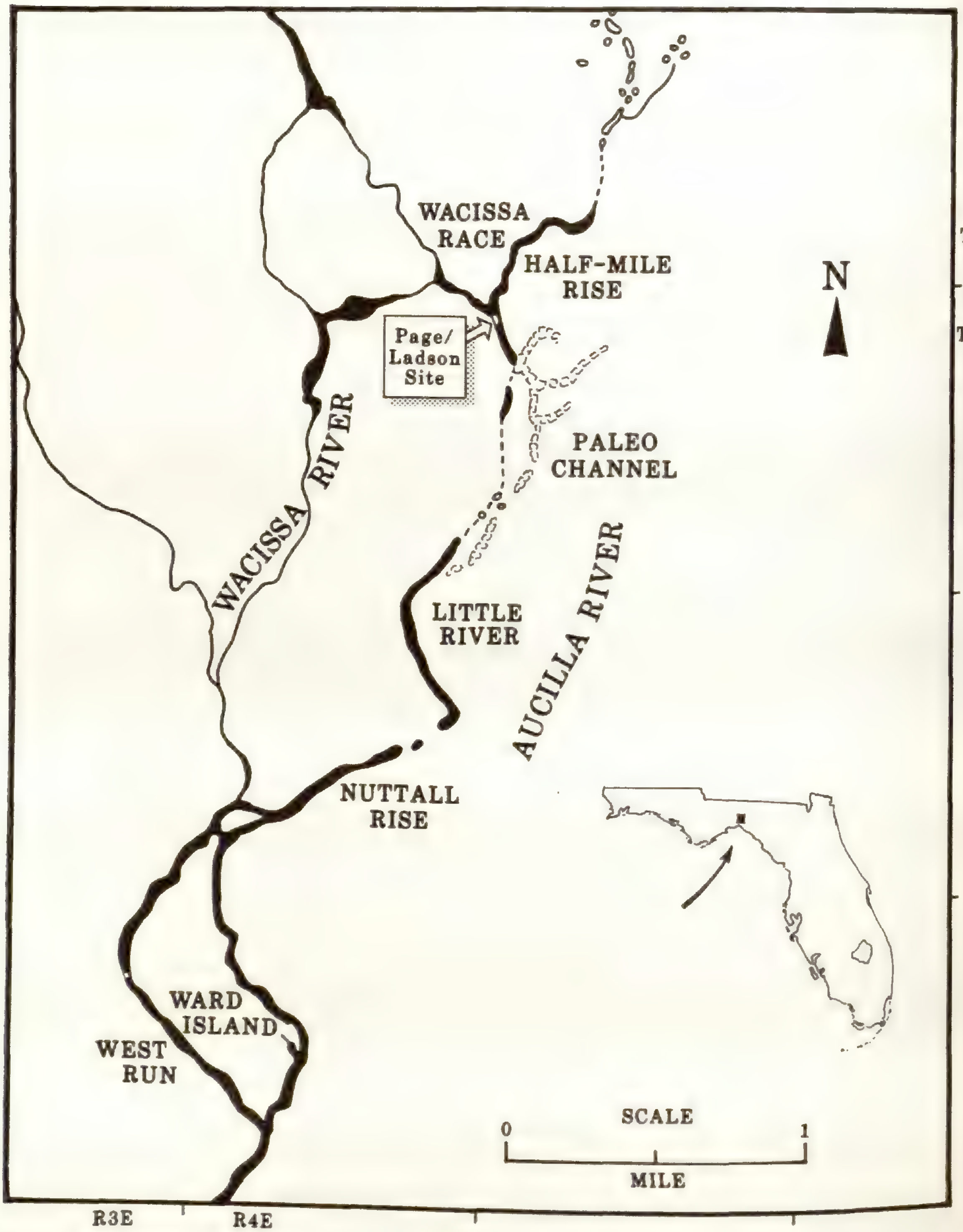


FIG 1.—Location of the Page-Ladson (8Je591) site in northwest Florida.

The calcareous deposits described above are capped in several places by a highly organic clay stratum (Levels 16–22, 1991 unit). Some pockets of organic clay occur also within the calcarenites, and, similarly, as isolated pockets of material overlying the primary organic clay concentration of Level 20B in the Test F excavation. The organic clay deposits are coarse in texture due to an abundance of loosely consolidated masses of woody fiber, twigs, and small stems. Lengths of these

TABLE 1.—Radiocarbon dates for Page-Ladson (8Je591), Florida.
(see also Dunbar et al. 1990)

| Age | Test | Sample/stratum |
|---|---|---|
| 3440 ± 70 B.P. (Beta) | B | bottom of ceramic-bearing deposit |
| 4070 ± 60 B.P. (Beta) | B | land bridge collapse (fluviation) |
| 8905 ± 65 B.P. (Ariz.) | C | wood stake from above "Bolen floor" |
| 9450 ± 100 B.P. (Beta) | B | clay with mulberry wood remains |
| 9730 ± 120 B.P. (Beta) | B | "Bolen-beveled" horizon |
| 10,000 ± 120 B.P. (Beta) | C | "Bolen floor" |
| 10,280 ± 110 B.P. (Beta) | C | "Bolen floor" |
| 10,600 ± 70 B.P. (Beta) | C | upper colluvium, calcarenite deposits |
| 10,520 ± 90 B.P. (Beta) | A | proboscidean bone in upper calcarenite |
| 11,770 ± 90 B.P. (Beta) | A | upper calcarenite |
| 11,790 ± 90 B.P. (Beta) | C | calcarenite deposits |
| 12,240 ± 90 B.P. (Beta) | C | bottom of core in unit, calcarenite deposits |
| 12,330 ± 110 B.P. (Beta) | B | calcarenite deposit |
| 12,375 ± 75 B.P. (Ariz.AMS) | C | FS 131[1] *Cephalanthus* twig, woody-organic clay |
| 12,545 ± 80 B.P. (Ariz.AMS) | C | FS 131[1] *Vitis* seed, woody-organic clay |
| 12,570 ± 200 B.P. (Teled.) | A | upper calcarenite |
| 12,570 ± 100 B.P. (Ariz.AMS) | F | lower calcarenite/red-brown peat (*Cucurbita* seed)[1] |
| 14,600 ± 115 B.P. (Ariz.) | C | lower peat deposit |
| 18,430 ± 220 B.P. (Beta) | E | "cypress-forest" peat |

[1]Sample with *Cucurbita*-gourd seeds.

fragments in one sample that has been intensively studied are strongly modal at 7–10 mm. We suggest elsewhere (Webb and Newsom 1991) that at least some of this material may represent proboscidean, specifically mastodon *(Mammut americanum),* dung. Two *Cucurbita pepo* seeds were recovered with a sample of hypothesized mastodon digesta, F.S. 131 from the 1988 excavation. Additional *Cucurbita pepo* seeds were recovered from similar deposits in Test F (Levels 14–25, see below). Accelerator radiocarbon dates on a buttonbush twig and a grape seed from F.S. 131 are 12,545 ± 80 B.P. (AA-7452) and 12,375 ± 75 B.P. (AA-7753), respectively (Table 1).

Remains of proboscidea and other extinct Pleistocene fauna appear in the red-brown peat, calcarenite, and woody organic clay deposits. Evidence at Page-Ladson of a direct association between early humans and Pleistocene fauna (and therefore also humans and Pleistocene-aged deposits that include *Cucurbita* gourd seeds) is limited, but not entirely absent. Worked ivory shafts and other specimens of humanly-modified megafaunal remains have been recovered from other locations along the Aucilla River (Dunbar et al. 1990; Webb et al. 1984). A few examples of apparently cut and worked megafaunal remains were recovered in our excavations at Page-Ladson, along with possible early PaleoIndian lithic tools.

The issue of whether PaleoIndians coexisted with Pleistocene megafauna in north Florida in general, and at Half-Mile Rise in particular, is beyond the scope of this paper. However, the earliest human use of the area is worth considering because the late Pleistocene/early Holocene strata at Page-Ladson include seeds of

TABLE 2.—Page-Ladson *Cucurbita pepo* contexts.

| Total Seeds | Field No. | Provenience | Matrix Type | Collection |
|---|---|---|---|---|
| 2 | 131 | 1988 Test C, Zone D | woody-organic clay, upper calcarenite | bulk sediment sample |
| 1 | 17-A | 1991 level 14 | woody-organic clay | excavation screen |
| 3 | 25-A | 1991 level 21 | woody-organic clay | excavation screen |
| 8 | 26-A | 1991 level 22 | woody-organic clay | excavation screen |
| 3 | 26.2 | 1991 level 22, southeast corner | woody-organic clay | bulk sediment sample |
| 6 | 26.3 | 1991 level 22, southwest corner | woody-organic clay | bulk sediment sample |
| 1 | 26.4 | 1991 level 22, northwest corner | woody-organic clay | bulk sediment sample |
| 3 | 28.4 | 1991 level 23, northwest corner | woody-organic clay | bulk sediment sample |
| 5 | 29-A | 1991 level 24 | woody organics in calcarenite levels | excavation screen |
| 1 | 29-B | 1991 level 24 | woody organic in calcarenite | bulk sediment sample |
| 1 | 30.4 | 1991 level 25, northwest corner | woody organics in calcarenite | bulk sediment sample |
| 1 | 32-A | 1991 level 26B | red-brown peat/ calcarenite contact | in situ[1] |
| 6 | — | unprovenienced | general calcarenite deposits | excavation screen |

[1]Seed in association with proboscidean skull.

*Cucurbita pepo,* a plant that was certainly utilized later by human groups in Florida and the eastern United States. The possibility exists that gourds at Page-Ladson are in some way tied to the earliest human appearance at the site.

*Page-Ladson Cucurbita pepo gourd seeds.*—Forty-one *Cucurbita pepo* seeds resembling the ornamental gourd *C. pepo* ssp. *ovifera* (Decker 1986, 1988) have been recovered from deposits at Page-Ladson (Table 2). Most come from the late Pleistocene woody-organic clay deposits.

The *Cucurbita pepo* seeds are in excellent condition, with intact, well-preserved margins and seed coats (Fig. 2). The two seeds from F.S. 131, possible mastodon digesta, however, are fragmentary. Marginal hair is essentially absent or in some cases very weakly developed. The tan-brown color and smooth, even, gently curved margins of the Page-Ladson seeds exclude indigenous *Cucurbita okeechobeensis,* the seeds of which have a greenish cast and relatively rough, angular margins.

Mean length for the Page-Ladson *Cucurbita pepo* seeds is 9.87 mm (Standard Deviation = 0.54), with a range of 8.75–11.15 mm (Table 3). The average width at

FIG 2.—*Cucurbita pepo* seeds from Page-Ladson: (a) seed from Level 26B, recovered in association with mastodon cranium; (b) seeds from Level 22.

TABLE 3.—Page-Ladson *Cucurbita pepo* seed measurements.[1]

| | | | Width | | | | |
|---|---|---|---|---|---|---|---|
| Seed/Provenience | | Length | Proximal | Mid-sect. | Distal | Thickness | W/L[2] |
| 1 | lv. 14, 91.17A | — | — | 6.96 | 4.41 | — | — |
| 2 | lv. 21, 91.25A | 9.48 | 2.49 | 6.28 | 4.42 | 1.04 | 0.66 |
| 3 | lv. 22, 91.26A | 9.90 | 2.70 | 6.15 | 5.23 | 0.50 | 0.62 |
| 4 | " | 10.05 | 3.15 | 7.20 | 4.80 | 0.90 | 0.72 |
| 5 | " | 9.90 | 2.90 | 6.15 | 4.50 | 0.70 | 0.62 |
| 6 | " | 10.40 | 2.45 | 7.10 | 5.15 | 1.20 | 0.68 |
| 7 | " | 10.15 | 2.83 | 7.10 | 4.80 | 0.90 | 0.70 |
| 8 | " | 10.40 | 2.70 | 6.30 | 4.83 | 1.05 | 0.61 |
| 9 | " | 10.15 | 2.15 | 6.80 | 4.95 | 1.05 | 0.67 |
| 10 | " | — | — | 7.10 | 5.00 | 0.90 | — |
| 11 | lv. 22, 91.26.2 | 10.46 | 2.88 | 6.80 | 4.51 | — | 0.65 |
| 12 | " | 9.14 | 2.36 | 6.38 | 4.78 | — | 0.70 |
| 13 | " | 10.03 | 2.66 | 6.45 | 4.47 | — | 0.64 |
| 14 | lv. 22, 91.26.3 | 10.15 | 2.65 | 6.72 | 5.07 | 0.55 | 0.66 |
| 15 | " | 9.11 | 2.61 | 6.53 | 3.68 | 0.95 | 0.72 |
| 16 | " | 10.13 | 2.26 | 6.17 | 4.77 | 1.00 | 0.61 |
| 17 | " | 8.73 | 2.00 | 5.07 | 3.46 | — | 0.58 |
| 18 | " | 9.32 | 2.45 | 6.47 | 4.44 | — | 0.69 |
| 19 | " | — | 2.36 | 5.95 | — | — | — |
| 20 | lv. 22, 91.26.4 | 10.13 | 2.28 | 6.43 | 4.54 | 0.85 | 0.63 |
| 21 | lv. 23, 91.28.4 | 9.71 | 1.91 | 5.94 | 3.91 | — | 0.61 |
| 22 | " | 10.03 | 2.65 | 6.71 | 4.48 | — | 0.67 |
| 23 | " | 8.89 | 2.84 | 6.47 | 4.72 | — | 0.73 |
| 24 | lv. 24, 91.29A | 9.71 | 2.49 | 6.49 | 4.40 | 0.63 | 0.67 |
| 25 | " | 9.97 | 1.85 | 6.82 | 4.72 | 0.95 | 0.68 |
| 26 | " | 9.61 | 2.15 | 6.86 | 4.87 | 0.79 | 0.71 |
| 27 | " | 10.55 | 2.37 | 6.94 | 5.02 | 0.42 | 0.66 |
| 28 | " | — | 2.27 | 5.64 | — | — | — |
| 29 | lv. 24, 91.29B | 9.35 | 2.70 | 7.00 | 5.25 | 1.00 | 0.75 |
| 30 | lv. 25, 91.30.4 | 10.40 | 1.93 | 7.30 | 4.50 | 1.00 | 0.70 |
| 31 | lv. 26b, 91.32A | 9.60 | 2.95 | 6.55 | 5.20 | 1.05 | 0.68 |
| 32 | level uncertain | 9.20 | 3.00 | 7.40 | 5.15 | 0.90 | 0.80 |
| 33 | " | 11.15 | 3.15 | 7.10 | 5.50 | 0.95 | 0.64 |
| 34 | " | 10.50 | 2.95 | 7.60 | 6.40 | 1.05 | 0.72 |
| 35 | " | 9.65 | 2.35 | 6.90 | 5.25 | 0.70 | 0.72 |
| AVERAGE | | 9.87 | 2.53 | 6.62 | 4.76 | 0.88 | 0.67 |
| Stand.dev. | | 0.54 | 0.35 | 0.51 | 0.53 | 0.19 | 0.05 |
| Variance | | 0.29 | 0.12 | 0.26 | 0.28 | 0.04 | 0.00 |
| Minimum | | 8.73 | 1.85 | 5.07 | 3.46 | 0.42 | 0.58 |
| Maximum | | 11.15 | 3.15 | 7.60 | 6.40 | 1.20 | 0.80 |

[1]Measurements in millimeters.

[2]Width to length ratio based on midsection (widest) width. Six fragmentary seeds were not measured: 2 from 1988 sample 131, 2 from lv. 21 no. 91.25A, and 2 without certain provenience.

mid-section is 6.62 mm (S.D. = 0.51; range 5.07–7.60 mm). All specimens are widest at mid-section, with the exception of a single seed from level 22 (seed number 3 in Table 3) that is widest just distal of the mid-section point. Overall length and width values for the Page-Ladson seeds fall within the range for modern ssp. *ovifera,* which includes ornamental gourds, scallop and crookneck squashes (var. *ovifera*), and wild gourds (var. *ozarkana,* var. *texana*) (Cowan and Smith, this volume; Decker 1986, 1988; Decker and Wilson 1986; Decker-Walters et al., this volume). The Page-Ladson seed dimensions, however, fall short of values for ssp. *pepo,* which regularly attain lengths of 12.0 mm and widths of at least 8.0 mm (Decker 1986, 1988; Decker and Wilson 1986). Width and length measurements for the Page-Ladson seeds compare favorably with other prehistoric assemblages of small-seeded *Cucurbita pepo* gourd from Florida (see below).

The Page-Ladson seeds are generally rounded in shape; width to length ratios range from 0.58 to 0.80 (very round) (Table 3). The sample mean, 0.67, agrees with W/L values for ssp. *ovifera* (e.g., Decker 1986; Decker and Newsom 1988; Decker and Wilson 1986). Given their great age, we have not attempted to assign the Page-Ladson seeds to an extant variety.

The coefficient of variation (C.V. = 100 × standard deviation/mean) applied to seed dimensions provides a more precise measure of the degree of morphological variability in a population than is evident using standard deviation alone. The C.V. for length among the Page-Ladson seeds is 5.5. This is relatively low and indicates a rather homogeneous population. The C.V. for width is higher, 8.0. High coefficients of variation may indicate presence of more than one fruit type and/or the initial effects of hybridization, cultivation, and selective breeding (Cowan and Smith, this volume). For example, values for the Phillips Spring site (King 1985; Cowan and Smith, this volume:Table 4) are moderately high (C.V. length = 8.7; C.V. width = 9.1) and have been interpreted, along with other data, as evidence that more than one form of *Cucurbita* gourd was present at that site. Thus, the somewhat smaller coefficients of variation for the Page-Ladson seeds may indicate that fewer, or perhaps a single, variety of gourd was present at the site.

## PREHISTORIC *Cucurbita pepo* GOURDS IN FLORIDA

Page-Ladson is the eighth location in Florida from which prehistoric gourd remains similar to *Cucurbita pepo* ssp. *ovifera* have been recovered (Fig. 3). The younger sites range in date from 4000 B.P. to the middle eighteenth century (Table 4). All are wet sites, primarily shell-midden deposits, with abundant, well-preserved organic materials. The recovery of gourd remains in association with fish nets or cordage fragments suggests that at some of these sites gourds functioned as net floats in a fishing tradition.

The seeds from the various Florida sites are very similar morphologically, with well-defined, rounded margins, sparse marginal hair, and gentle narrowing toward the seed sinus region. Occasional seeds have more attenuated curvature toward the sinus area. Thirty-two seeds from Pineland (Table 4) differ by the presence of dense marginal hair, an apparently tomentose seed coat, and rougher, somewhat thicker margins. These seeds are undersized for *Cucurbita moschata;* rather, they give the impression of being a cross between indigenous *C. okeechobeensis* and

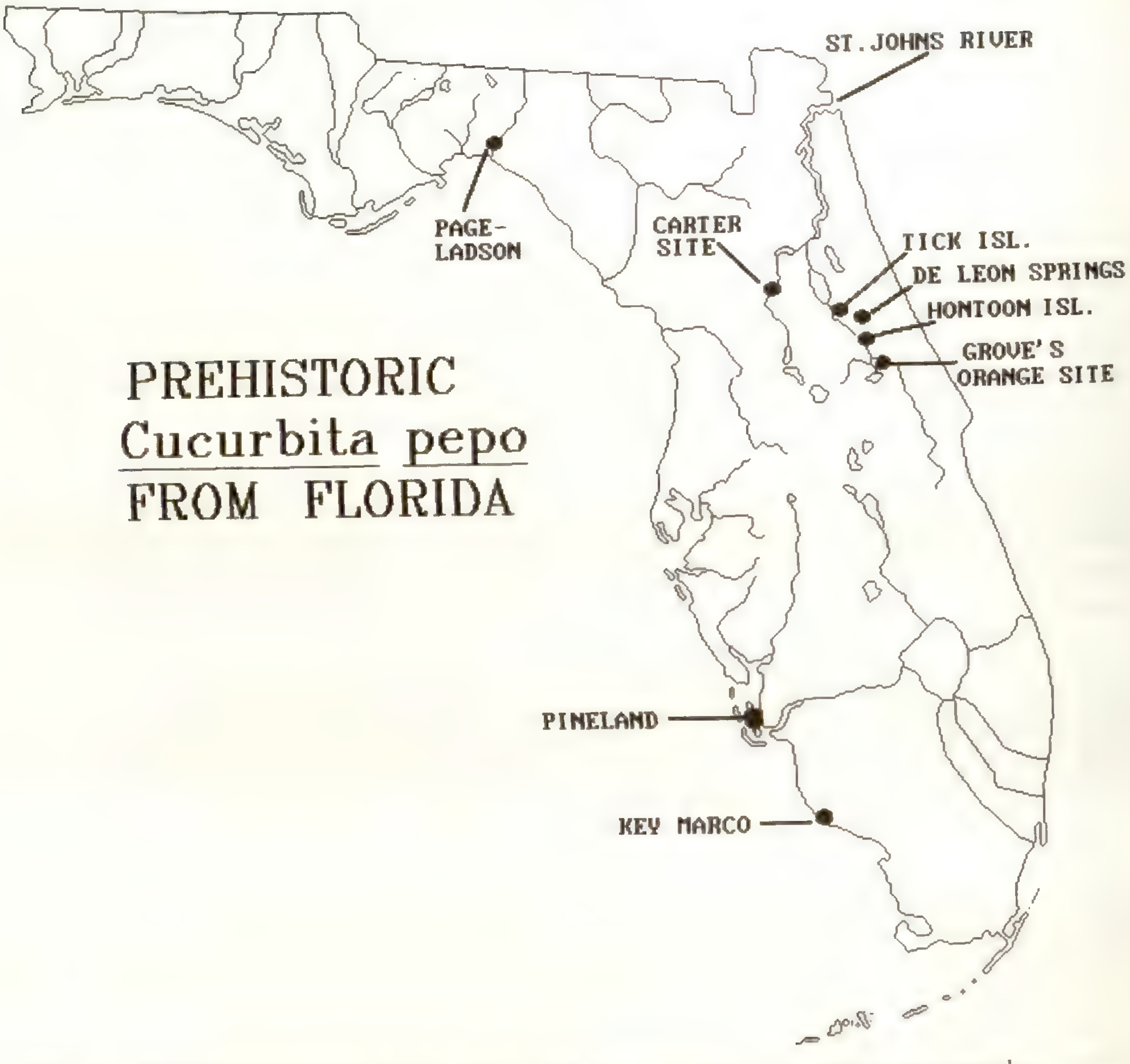


FIG. 3.—Florida archaeological sites with prehistoric *Cucurbita pepo* seeds.

*C. pepo* ssp. *ovifera*. The distinctive Pineland seeds may represent a previously unrecognized form of *Cucurbita*. For the present purposes, the unusual Pineland seeds are classified as *C. pepo* ssp. *ovifera* with the rest of the Pineland seeds, unless and until further analysis indicates the seeds should be treated separately.

Summary statistics for *Cucurbita pepo* gourd seeds from the Florida sites described above are shown in Table 5; measurements of *Cucurbita pepo* ssp. *ovifera* var. *ovifera* seeds recovered from a sixteenth century well in St. Augustine are included for comparative purposes since these seeds almost certainly represent domesticated plants. Average seed length for the combined populations is 9.43 mm (S.D. = 1.13); average seed width is 6.22 mm (S.D. = 0.45) (Table 5). The coefficients of variation for prehistoric seeds range from relatively low (around 4.0) to moderately high (approaching 10.0). Rather homogenous populations with a narrow range of fruit forms (morphotypes) may be indicated by the relatively low length coefficients of variation (3.0–6.5) for Hontoon Island, Key Marco, Pineland, and as discussed earlier, Page-Ladson (length C.V. 5.5). The corresponding width coefficients for these sites (4.0–10.0) suggest somewhat greater variability.

TABLE 4.—Florida site contexts with *Cucurbita* gourds.

| Site | Location | Age | |
|---|---|---|---|
| Page-Ladson (8Je591) | Aucilla River Jefferson Co. | ca. 12,500 B.P. | Webb et al. 1984. |
| Carter Site (8Mr2061) | Oklawaha River Marion Co. | ?early Holocene | Denson et al. 1992. |
| Tick Island | St. Johns River Volusia Co. | 5000–2000 B.P.; & possibly later[1] | Jahn and Bullen 1978; Purdy 1991; Newsom and Purdy 1990. |
| DeLeon Springs | spring/sinkhole Volusia Co. | ca. 5000 B.P.[2] | Purdy 1991; Newsom and Purdy 1990. |
| Groves' Orange Midden (8Vo2601) | Lake Monroe (St. Johns Riv) Volusia Co. | 4165 B.P. to ca. 500 B.P., possibly later | Russo et al. 1992. |
| Hontoon Island (8Vo202) | St. Johns River Volusia Co. | 3000–200 B.P. | Decker and Newsom 1988; Newsom 1987; Purdy 1991. |
| Pineland (8LL37) | coastal midden Lee County | ca. 1900 B.P., possibly also as late as 500 B.P. | Marquardt 1992. Walker and Marquardt 1994. |
| Key Marco | mangrove swamp Collier Co. | 1100–1300 B.P. | Cushing 1897; Cutler 1975; Gilliland 1975. |
| St. Augustine | Spanish well, St. Augustine | 16th century | Scarry 1985. |

[1]Seeds (3 total) came from a sediment core that penetrated shell midden deposit with Orange and St. Johns Plain ceramics series (ca. 2000 B.C.–A.D. 500 [Milanich and Fairbanks 1980:149]).

[2]Seeds (3) came from a peat core at 10 cm above a dugout canoe with a radiocarbon date of 5140 ± 100 years B.P. (Beta-14893). The canoe rested on limestone bedrock and was buried in the cucurbit-bearing peat; the relationship between the canoe (date) and seeds is uncertain.

Similarities among the coefficients for Hontoon, Key Marco, Pineland, and Page-Ladson—the last almost certainly representing free-ranging gourds—suggest that little or no selective pressures were placed on local gourd populations by human inhabitants of the first three sites. In contrast, values for Groves' Orange Midden (C.V. = 12.0, length; C.V. = 14.0, width) and the length coefficient for the domesticated population from St. Augustine (C.V. = 18.3) are at least twice as high as the values for the other Florida sites. The relatively high values for Groves' Orange Midden reflect the presence of a single seed that is exceptionally large (length 12.79 mm, width 8.41 mm) compared to the rest of the group (Table 5). This large seed, from Level 3, may represent a distinct morphotype, indicating that at least two forms of *Cucurbita pepo* may have been present at the Groves' Orange Midden site (if this seed is excluded, the Groves' Orange Midden coefficients decrease to 6.5 for length and 9.0 for width). Likewise, the extremely high length coefficient of the St. Augustine seeds probably reflects the presence of a more diverse array of *Cucurbita pepo* fruits and/or an expanded genetic base. The St. Augustine seeds derive from cultivated population(s) that undoubtedly included

TABLE 5.—Summary statistics for *Cucurbita pepo* gourd seeds from Florida sites.[1]

| | | Length | | | | Width | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Seed Population | N | Mean | Range | STD | C.V. | Mean | Range | STD | C.V. | W/L |
| St. Augustine[2] | 15 | 11.71 | 9.40–15.65 | 2.14 | 18.3 | 6.86 | 5.87–7.45 | 0.34 | 5.0 | 0.60 |
| Hontoon Island[3] | 1,120 | 9.09 | 6.95–11.57 | 0.54 | 6.0 | 6.05 | 4.22–8.02 | 0.43 | 7.0 | 0.67 |
| Hontoon type-2 | 26 | 10.91 | 10.25–11.57 | 0.40 | 4.0 | 7.46 | 6.72–7.97 | 0.35 | 5.0 | 0.68 |
| Hontoon type-1 | 1,094 | 8.97 | 6.95–10.70 | 0.27 | 3.0 | 5.96 | 4.22–8.02 | 0.23 | 4.0 | 0.66 |
| Hontoon-shell | 919 | 9.23 | 6.95–11.57 | 0.61 | 6.6 | 6.18 | 4.22–8.02 | 0.45 | 7.0 | 0.67 |
| Hontoon-snail | 201 | 8.88 | 7.15–10.40 | 0.30 | 3.4 | 5.85 | 4.22–7.30 | 0.31 | 5.0 | 0.66 |
| Key Marco | 48 | 9.40 | 8.50–10.52 | 0.46 | 5.0 | 6.37 | 5.30–7.35 | 0.50 | 8.0 | 0.68 |
| Pineland | 98 | 9.34 | 7.96–10.84 | 0.61 | 6.5 | 6.32 | 4.78–7.52 | 0.63 | 10.0 | 0.68 |
| Groves' Orange | 11 | 9.55 | 7.75–12.79 | 1.17 | 12.0 | 6.54 | 5.25–8.41 | 0.92 | 14.0 | 0.68 |
| Tick Island | 1 | 10.25 | | | | 6.22 | | | | 0.61 |
| DeLeon Springs | 2 | 8.20 | 7.89– 8.52 | | | 5.63 | | | | 0.69 |
| Carter Site | 1 | 7.50 | | | | 5.37 | | | | 0.72 |
| Page-Ladson | 35 | 9.87 | 8.73–11.15 | 0.54 | 5.5 | 6.62 | 5.07–7.60 | 0.51 | 8.0 | 0.67 |
| GRAND TOTAL | 1,331 | | | | | | | | | |
| GRAND MEAN | | 9.43 | | 1.13 | 12.0 | 6.22 | | 0.45 | 7.0 | 0.67 |
| same w/o TI,DS,CS | | 9.83 | | 0.87 | 9.0 | 6.46 | | 0.25 | 4.0 | 0.66 |
| GRAND MEAN[4] | | 9.12 | | 0.84 | 9.0 | 6.12 | | 0.42 | 7.0 | 0.67 |

[1]Measurements in millimeters. STD = Standard deviation; C.V. = coefficient of variation.

[2]The St. Augustine seeds came from a sixteenth century well associated with Spanish-Indian settlement. They probably represent cultivated gourds. Seeds were provided by C.M. Scarry.

[3]Hontoon Type-2 are seeds classified by Decker and Newsom (1988) as *C. pepo* ssp *ovifera* var. *ovifera* (scallop-like seeds); Hontoon Type-1 is the smaller-sized, abundant type from Hontoon Island. Hontoon-shell is the mussel-shell midden that developed primarily during the historic period. Hontoon-snail refers to prehistoric midden composed primarily of freshwater snail. Large "variety *pepo*" seeds from historic period deposits at Hontoon Island (Newsom 1987) were not included in this analysis.

[4]Prehistoric populations only.

domesticated *Cucurbita pepo,* and a gardening situation where hybridization between introduced and native forms of *Cucurbita* was unimpeded by distance or isolation.

For the purposes of this analysis the St. Augustine seeds serve as an archaeological example of domesticated *Cucurbita pepo* gourd, while Page-Ladson, at the other extreme, is representative of wild, free-ranging *Cucurbita.* With these standards, the coefficients of variation may be used indirectly to verify the advent of gardening or the intensification of gardening practices and perhaps human-directed selection for fruit characters at each of the Florida sites (Decker and Newsom 1988:40–42; also see Heiser 1989). By this measure, there is an increase in the length and width coefficients from 3.4 and 5.0, respectively (Table 5), for the prehistoric Hontoon Island snail-shell midden to 6.6 and 7.0, respectively, for the primarily mussel-shell midden that accreted during the latest prehistoric-historic period. This change may track the adoption of gourd cultivation or an intensification of cultivation practices and manipulation of local gourd populations. The appearance of morphologically distinct "type-2" (scallop-type) *Cucurbita pepo* seeds (Decker and Newsom 1988) occurred slightly prior to or in the transition between the two distinctive middens at Hontoon Island. The standard deviations and ranges (length 10.25–11.57; width 6.72–7.97) for the Hontoon Island type-2 seed sample are, however, within the limits of seed size variability for free-ranging gourds as documented by Cowan and Smith (this volume).

## FLORIDA GOURD POPULATIONS IN BROADER PERSPECTIVE

It is probable that *Cucurbita pepo* seeds from St. Augustine, and possibly also Hontoon Island type-2 and the large seed from Groves Orange Midden, are archaeological examples of domesticated *Cucurbita pepo.* The older *Cucurbita pepo* gourd remains from other Florida sites help establish the range and variability of seed size, and corroborate other morphological characteristics associated with independent or free-ranging *Cucurbita pepo* gourds. This baseline is important because it provides criteria of seed size and rind character that may be employed in determining which prehistoric gourd populations in eastern North America represent free-ranging and which represent truly domesticated forms of *Cucurbita pepo,* whether introduced or developed *in situ.* Such determinations are necessary to understand the timing and trajectory of indigenous plant husbandry systems.

The data base provided by the Florida seeds is valuable because of its time range—more than 12,500 years—and particularly because the Page-Ladson gourds are unlikely to represent domesticated plants. Thus, we have a paleontological example of what numerical values may be considered representative of clearly wild plants, as opposed to gourds under incipient or full domestication. The sheer quantity of gourd material from Florida is also useful in establishing a reliable base of figures with which to compare other data. This information may then be used in conjunction with data generated from modern and extant free-living gourd populations (Cowan and Smith, this volume; Decker 1986, 1988).

As a general rule, archaeological assemblages in which gourd seed lengths surpass 11.00 mm are considered to represent gourds that have undergone some degree of domestication (King 1985; Cowan and Smith, this volume). Individual

seeds with lengths greater than 11.00 mm are absent among the prehistoric *Cucurbita pepo* gourd seed assemblages from Florida, with the exception of a single seed from Page-Ladson (Table 3). All seeds greater than 11.00 mm from Hontoon Island come from historic period deposits; the large seed from Level 3 of the Groves Orange Midden may also be recent, based on the proximity of historic period artifacts. As the 12,500 year old seeds from Page-Ladson almost certainly come from wild gourds, presence of a single seed larger than 11.0 mm at that site underscores the cautionary note by Cowan and Smith (this volume) and others that seed size alone is an unreliable indicator of domesticated status. Likewise, just as the > 11.00 mm length baseline should be applied cautiously when attempting to interpret the timing and scale of domestication, so then should smaller seed sizes not always be equated with the wild state (Cowan and Smith, this volume; Decker and Newsom 1988). Interestingly, some of the smallest seeds from Hontoon Island appear in the latest strata when overall *Cucurbita pepo* seed morphological diversity appears to reach its highest level (Decker and Newsom 1988).

Thus, seed size, to the extent upon which it can be relied, generally places the prehistoric archaeological populations of *Cucurbita pepo* from Florida under the size range (> 11 mm) commonly associated with domesticated forms. By this measure, sixteenth century specimens from St. Augustine, with lengths that attain 15.00 mm, are the only seeds that fit securely within size ranges established for seeds of squash/gourd domesticates.

Rind thickness, rind texture, and peduncle diameter are characteristics that have also been used to assess free-ranging versus domesticated status in *Cucurbita pepo* gourds. The Hontoon Island small-seeded form of *Cucurbita pepo* gourd (Table 5: Hontoon-snail, type-1) is accompanied by smooth-surfaced, thin-shelled rind and peduncles with relatively small basal diameters (Table 6). Mean rind thickness of less than 2 mm and a lack of lobing and/or wartiness are characteristics that researchers have associated with free-living *Cucurbita pepo* gourds (Cowan and Smith, this volume). Rind from the Hontoon Island collection, therefore, being thin and smooth-surfaced, does not differ morphologically from that of wild gourd, at least in any way we can recognize. Furthermore, Cowan and Smith (this volume) have compared basal peduncle diameters (as a direct reflection of relative fruit volume) from free-living and cultivar forms of *Cucurbita pepo* gourd, concluding that peduncle diameters larger than 8 mm are more consistently associated with domesticated status (mean 9.75 mm, range 6.20–15.10 mm). However, Cowan and Smith's data show that free-living forms may approach 9 mm (mean 5.60 mm, range 5.30–8.60 mm). The mean for Hontoon Island peduncle diameters (7.61 mm) is about equidistant between modern free-living and cultivar gourds, but the overall values are generally more similar to the free-living specimens (Table 6). Two peduncle diameters for Pineland are similar. Together, these characteristics (relatively small seeds, thin rinds, small peduncle diameter) demonstrate that the most abundant seed type at Hontoon Island represents a *Cucurbita pepo* gourd that was free-ranging or otherwise displayed no phenotypic alteration that is readily attributed to direct human manipulation.

Whether the larger, type-2 seeds present at Hontoon Island represent a spontaneous mutation from the first type of gourd, intentional selection, or a gourd introduction, is not clear, but there is no associated thicker (> 2 mm) or warty

TABLE 6.—Rind thickness and peduncle diameters for Florida gourd assemblages.[1]

| | Rind Thickness | | | | Peduncle Diameter | | |
|---|---|---|---|---|---|---|---|
| Site | N | Mean | Range | STD | N | Mean | Range |
| Hontoon Island | 30 | 1.08 | 0.72–1.55 | 0.22 | 7 | 8.15 | 7.00–9.80 |
| Key Marco | ? | — | 1.80–2.20 | — | 0 | — | — |
| Pineland | 0 | — | — | — | 2 | 8.23 | 7.43–9.04 |

[1]Measurements in millimeters.

rind at Hontoon Island indicating a domesticated form of *Cucurbita*. Cutler (1975:256) reported somewhat thicker *Cucurbita pepo* rind for Key Marco (Table 6). Key Marco *Cucurbita* specimens curated at the Florida Museum of Natural History all have smooth rind surfaces, however, like those from Hontoon Island.

Numerical analysis (Decker and Newsom 1988) of a sample of 252 *Cucurbita pepo* gourd seeds from Hontoon Island classifies all specimens within ssp. *ovifera*. Moreover, the small seed type from Hontoon Island exhibits a strong affinity (64% classified) with wild var. *texana,* while larger seeds, including the type-2 scallop specimens, fall within var. *ovifera*. The strong identification with var. *texana* further supports the general impression that Hontoon Island gourds, especially those from prehistoric levels that predate the appearance of the larger-seeded type, were not advanced in the domestication process or at least do not display characteristics generally associated with domestication. The same may be true of the other Florida sites for which the majority of seeds are less than 11 mm in length, but currently there are few or no rinds or peduncles to corroborate the evaluation of domesticated versus free-ranging status utilizing seed length. Moreover, the fact that plant cultivation was of little or no significance throughout most of Florida's prehistory (Milanich 1987; Newsom 1986; 1991, 1993; Scarry and Newsom 1992), further supports the conclusion that prehistoric people in Florida typically made use of free-ranging gourds. Perhaps in some cases a low level of influence was exerted on local gourd populations that is not detected by the measures described above.

It is worth noting that the abundant, small-seeded morphotype from Hontoon Island occurs throughout the stratigraphic sequence at that site and may have survived site abandonment: a few seeds occur in postoccupation levels. The capacity of the gourd to survive without human assistance is additional, albeit inconclusive, evidence of its nondomesticated status. *Cucurbita pepo* gourd remains from Hontoon Island provide the longest, continuous record in Florida for the gourd's presence, extending from a prehistoric deposit of ca. 3000 B.P. to as late as the mid-eighteenth century, based on radiocarbon dates and artifacts of European origin.

The absence of free-ranging gourds along the St. Johns River today is an interesting problem. However, in 1774 William Bartram observed wild gourds growing in the St. Johns River basin (Harper 1958). Although his description may apply to the endemic Okeechobee gourd (*Cucurbita okeechobeensis*) (e.g., Walters and Decker-Walters 1993; Martin 1992), it is possible that what Bartram saw were

descendants of the archaeological St. Johns River basin gourds. Bartrum's description of "the wild squash climbing over lofty limbs of the trees; their yellow fruit somewhat of the size and figure of a large orange, pendant from the extremities of the limbs *over the water*" [emphasis added] (Harper 1958:87) possibly applies to *Cucurbita pepo* gourds. Fruit color (yellowish to various shades of tan/brown) and shape (based on the ca. 15-degree angle of curvature) of rind specimens from Hontoon Island are consistent with Bartram's description of a yellow (?dried), roundish, orange-sized fruit. Moreover, 1774 is not far removed from the terminal radiocarbon dates for Hontoon Island: 170 ± 50 B.P. (A.D. 1770), 220 ± 45 B.P. (A.D. 1730), and 260 ± 50 B.P. (A.D. 1680) (Purdy 1987, 1991). The late survival of *Cucurbita pepo* gourds at Hontoon Island, together with Bartram's description of gourds growing somewhere in the vicinity of Lake Dexter, located in the middle river basin only 12 miles north of Hontoon Island, may attest to survival of the archaeological gourd population into relatively recent times. Bartram related to Muhlenberg (Harper 1958:633) that hunters called the gourd "wild squash." The name, coupled with Bartram's description of the habit, implies that the gourds retained characteristics and behaviour associated with the wild state—specifically, the ability to grow and disperse spontaneously, without human intervention. Bartram's portrayal of gourds hanging directly above the river provides a glimpse of how readily fruits could have dispersed along the water course, and supports the suggestion of a long-established pattern of natural dispersal by water routes, as Smith et al. (1992) have hypothesized regarding the niche and expansion of "easternized" *Cucurbita pepo* gourds.

## EARLY GOURDS IN FLORIDA AND EASTERN NORTH AMERICA

Middle Holocene *Cucurbita pepo* gourd remains are known from several locations across the eastern United States (Cowan and Smith, this volume; Fritz 1990; King 1985; Smith 1987, 1992; Watson 1989). These remains pre-date the hypothesized 3000–4000 B.P. time frame when gardening and human-induced morphological change in gourd specimens are thought to appear (Smith et al. 1992). Previous to the Page-Ladson discoveries, the earliest (7000 B.P.) remains possibly attributable to *Cucurbita pepo* were from west-central Illinois (Conard et al. 1984; Cowan and Smith, this volume); dates nearly as early come from eastern Tennessee (6990–5300 B.P.) (Crites 1991). Dates of around 4500 B.P. are recorded for south-central Missouri (Kay et al. 1980) and eastern Kentucky (Cowan 1990). Recently, *Cucurbita* sp. rind recovered from a hearth-like feature at the Sharrow Site in Maine (N. Asch Sidell in Petersen 1991) has been directly dated by the accelerator radiocarbon method to 5695 ± 100 B.P. (AA-7491) (James Peterson, personal communication, 1992). The Florida *Cucurbita pepo* gourd identifications thus extend the geographic and temporal records for early gourds. The 12,500 B.P. radiocarbon dates for Page-Ladson push the presence of eastern gourd back into the closing stages of the Pleistocene epoch.

Some previous interpreters of early *Cucurbita pepo*-like gourds in the eastern United States have tended to view them as having been transported from Mexico via down-the-line exchange or similar mechanisms (e.g., discussion summarized in King 1985). Some researchers consider the earliest appearances in the East of

*Cucurbita pepo* gourd to represent fully-domesticated forms (Asch and Asch 1992; Kirkpatrick and Wilson 1988; cf. Fritz 1990). The Page-Ladson seeds document that an eastern Pleistocene *Cucurbita pepo* gourd may have been growing in Florida prior to the appearance of PaleoIndians, and thus strengthen the case for introduction by natural, rather than by cultural means, as well as presenting the possibility for entry into North America prior to 12,500 B.P.

It is not difficult to envision how Pleistocene *Cucurbita pepo* gourds could have dispersed from an early Mexican origin and center of diversity (Decker-Walters et al., this volume; Nee 1990) to Florida and the eastern United States without the aid of human intervention. Indeed, Decker-Walters et al. (this volume) postulate an ancient range for wild *Cucurbita pepo* that stretched from central or southern Mexico north to the Ozark Plateau and east to the Florida peninsula. Furthermore, the coastal plain and Florida platform were considerably larger in the late Pleistocene, when much lower sea levels exposed vast areas of the now-submerged continental shelf stretching from Florida to Yucatan. The greatly expanded coastal plain, known to paleogeographers as the Gulf Coastal Corridor, became a major migration route for Pleistocene mammals (Morgan 1991; Webb 1989, 1991; Webb and Wilkins 1984), as well as for terrestrial vegetation (Long 1974; Tomlinson 1980). Some 17–34% of successive Pleistocene-neotropical mammalian faunas dispersed through this corridor and became established in the eastern United States (Webb and Wilkins 1984). That proboscideans may have acted as animal vectors for early gourd dispersal has been suggested by other researchers (Janzen and Martin 1982; Nabhan 1987); the possibility that one context for the Page-Ladson seeds is mastodon digesta is especially intriguing in this regard.

Mirroring and perhaps in conjunction with Decker-Walters's (Decker-Walters et al., this volume) hypothetical range expansion of an early *Cucurbita pepo* ancestor, we postulate a natural eastward dispersal of wild *Cucurbita pepo* around the Gulf Coastal Corridor from source areas in Mexico. Heiser (1979, 1989, 1990) and others have discussed how early bottle gourd *(Lagenaria siceraria)* might have first appeared in Florida (7290 $\pm$ 120 B.P. [Doran et al. 1990]) and the eastern United States by water-dispersal along the Gulf Coast from tropical regions. Given the apparently similar adaptation of free-ranging *Cucurbita pepo* (Cowan and Smith, this volume; Smith et al. 1992), we envision, as does Smith (1992:285), the small round gourds being deposited at the mouths of rivers along the Mexican coast and subsequently being transported eastward along the coast by drift and the clockwise flow of the Gulf Stream (Gunn and Dennis 1976; Guppy 1917), to end up at the mouths of other river systems from present-day Texas to Florida. Indeed, a look at distribution maps constructed by Nee (1990:Fig. 2) for wild var. *texana* and other closely related types reveals a strong association with Gulf coastal regions. Once established in the lower basins of easterly rivers, the wild gourds could eventually "migrate" with annual floods, and perhaps also with the aid of large mammalian dispersers, until their populations reached well up into the midwestern United States, culminating in the long-established "easternized" gourd of Smith et al. (1992). The process of natural dispersal and movement of gourds into and around the greater eastern temperate region may have been ongoing for millennia, and eventually aided by human groups who took up the gourds as a useful and edible plant.

The Gulf coast and Florida were cooler than present in the Pleistocene, enough so that at the glacial maximum of ca. 18,000 years B.P. spruce pollen is recorded for northern Florida (Watts and Hansen 1988; Watts et al. 1992). At other times, such as following the peak glacial advance of 18,000 B.P., the Gulf coast was considerably more arid than present, but ambient temperatures were not appreciably lower (Watts and Hansen 1988). Cooler conditions along the Gulf coastal plain may have allowed the tropically-derived Cucurbitaceae to adjust to climatic conditions along the routes of entry into more temperate zones, again facilitating the naturalization ("easternization") of gourd populations.

## CONCLUSIONS

At least as early as the terminal Pleistocene, *Cucurbita pepo* gourds dispersed from an early center in Mexico (Decker-Walters et al., this volume; Nee 1990) into Florida and probably elsewhere in the eastern United States. New evidence from the Aucilla River places *Cucurbita pepo* in Florida by 12,500 years ago. The status of early gourd remains in North America has been controversial. The question has been whether *Cucurbita pepo* gourds that pre-date clearly domesticated forms of the plant at eastern North American sites were domesticated plants from Mexico that were introduced by Native Americans, or, in contrast, whether the early *Cucurbita* gourds were an indigenous wild type or types that were long utilized and eventually taken into cultivation and domesticated by native peoples of the eastern woodlands (Fritz 1990; Smith 1987; Watson 1989). The 12,500 year old *Cucurbita pepo* seeds from Page-Ladson arguably pre-date domestication of the species, although the 8000–10,000 B.P. reportedly domesticated specimens from Mexico closely approximate this age (Whitaker et al. 1957; Whitaker and Cutler 1971; cf. Flannery 1973, and Heiser 1989, 1990). The basis for the domesticated status of early Mexican *Cucurbita* remains is unclear, however, and in light of the early material from Florida, is greatly in need of reevaluation. Unless we are ready to consider the possibility of PaleoIndian gardening and plant protection, it seems most plausible to assume that the earliest eastern gourd finds are remains of wild plants.

The growing archaeological record of earlier and more widely distributed *Cucurbita pepo* gourd remains in the East, however, lends increasingly greater support to the interpretation that the plant was present as part of the native flora by the time Native Americans populated eastern North America. Decker-Walters and her colleagues (Decker 1986, 1987, 1988; Decker-Walters et al., this volume) have demonstrated distinct genetic relationships among cultivar forms of *Cucurbita pepo*, modern free-living gourds in the east, and other wild gourds, leading her recently (Decker-Walters et al., this volume) to conclude that gourd populations north of Texas are the result of a long developmental history in relative isolation. Numerical analysis of seeds from Hontoon Island, Florida (Decker and Newsom 1988) produced results that at least superficially link modern ssp. *ovifera*, including a representative wild form, var. *texana*, and archaeological specimens. Thus, it is becoming increasingly more difficult to explain eastern *Cucurbita pepo* and indigenous plant production systems as a function of, or derivative of, borrowed plants and ideas from Mexico. The present evidence better supports the view explicated

by Smith (1987) and others (see, for example, Cowan and Smith this volume; Decker 1988; Fritz 1990; Heiser 1989, 1990; Smith et al. 1992; Watson 1989; Whitaker and Carter 1946) that eastern *Cucurbita pepo* gourds are part of the native flora, and that within the sphere of early plant domestication focused on indigenous wild taxa, a separate, eastern United States center of domestication existed for *Cucurbita pepo*.

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## BOOK REVIEW

**Household Ecology: Economic Change and Domestic Life Among the Kekchi Maya in Belize.** Richard R. Wilk. Tucson and London: University of Arizona Press, 1991. $55.00 (clothbound). Pp. xx,280. ISBN 0–8165–1214–0.

It would be difficult to find a more fitting title for this scholarly and very readable book (although "household ecology" is arguably redundant). This is a comprehensive treatment with ten informative figures and 28 tables of data—a reflection of Wilk's familiarity with the study area, the Kekchi people and their interactions with their natural and agricultural ecosystems, themselves and with the so-called "outside world."

The extended preface is informative and it should not be skipped. In the introductory chapter, Wilk gives a brief historical and theoretical background followed by an outline of the book, chapter by chapter: Household social evolution; The household as a unit of analysis; The historical and ethnographic setting; The physical setting; Land tenure and crops; Domestic animals; Hunting and gathering; Economic change; The organization of labor; Households as adaptive groups; and Household history and ecology.

Predictably, this book will hold greater appeal for professional anthropologists than ethnobiologists, and I feel certain the author had the former group in mind as the primary targeted readership. Nonetheless, as a general ethnobotanist, I found the last half of the book, and especially chapters 6 through 9, meaty with concepts and discussions not only interesting but also germane to studies in ethnobiology and I suggest that investigators in this discipline might find ideas to consider in their research.

Although the price of the book will perhaps discourage at least some ethnobiologists from adding it to personal collections, I certainly recommend it as an important acquisition to institutional libraries.

Willard Van Asdall, Past Editor
*Journal of Ethnobiology*
4479 N. Summer Set Loop
Tucson, AZ 85715, USA

## BOOK REVIEW

**Traditional Plant Foods of Canadian Indigenous Peoples: Nutrition, Botany, and Use.** Harriet V. Kuhnlein and Nancy J. Turner. Volume 8 in the Food and

Nutrition in History and Anthropology Series, edited by Solomon Katz. New York and Philadelphia: Gordon and Breach Science Publishers, 1991. Pp. xi, 620. 48 figures, 3 maps. $88.00 (hardbound), $38.00 for individuals who are members of Science and Arts Society. ISBN 2–88124–465–3.

Ethnobotanical studies amongst Aboriginal Peoples in most parts of North America are "few and far between." It is indeed encouraging that such a highly detailed and thorough report on food plants and nutrition of the Indigenous Peoples of Canada has appeared. The two authors—a well known nutritionist from McGill University and a widely respected ethnobotanist—are to be congratulated for their presentation of such a masterly contribution.

The forward by Laurie Montour, a Native Canadian and a staff member of the Assembly of First Nations, sets the tone of the book: "We need to work hard together to preserve our knowledge and to protect the environments of the plant foods of the world's indigenous people. This book is a good step along the way." In the Acknowledgments, the authors indicate the great number of individuals—aboriginal consultants, students, governmental agencies, and scientific colleagues—whose contributions have helped make this book the encyclopedic masterpiece that it is. The Introduction, Chapter 1, tells us that "The scientific literature was searched for nutrient information of approximately 1,050 species that were identified as edible and available in Canada," and that ". . . nutritional, botanical and ethnological data for more than 1,000 species of edible plants" are included.

There follows Chapter 2, "What's So Special About Indigenous Foods?" Amongst other "specialties" is the usefulness of information in "genetic research, in enhancing existing crops or . . . developing new ones." Chapter 3 deals in depth with "An Overview of the Nutrient Value and Use of Plant Foods by Indigenous Peoples." In the fourth chapter—a major section of the book—are considered the botany and methods of use of indigenous plant foods of Canada. A comprehensive list of plant food species makes up Chapter 5, a convenient tabular summary of earlier chapters. Another tabular chapter deals with "Nutrient Values of Traditional Plant Foods"—a most useful addition that occupies 162 pages.

The Bibliography comprises 519 items and is followed by three Appendices: Linguistic Affiliations and Locations of Indigenous Peoples of Canada (with three maps); Species by Common Name; and Species by Botanical Name. The Index contains both common and scientific plant names, and nutritional and other chemical constituents of the food plants.

This volume will certainly long remain an example of the very finest in ethnobotanical literature. Furthermore, its utility will be evident as a manual for quick consultation by specialists, as a valuable text or classroom reference work, and as an instrument furthering the development of the interdisciplinary field of ethnobotany.

Richard Evans Schultes
Director Emeritus
Botanical Museum of Harvard University
Cambridge, Massachusetts

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# NEWS and COMMENTS

Notes may be submitted on **CONFERENCES AND SEMINARS** and **REQUESTS FOR INFORMATION** in addition to the sections included below. Because the *Journal* is published only twice a year, dated items must be received at least six months in advance of the event.

## BOOK REVIEWERS NEEDED

The following titles have been received for review in the *Journal of Ethnobiology.*

**Human Adaptation in the Upper Mississippi Valley: A Study of the Pammel Creek Oneota Site (47Lc61) La Crosse, Wisconsin.** Constance M. Arzigian, Robert F. Boszhardt, James L. Theler, Roland L. Rodell, and Michael J. Scott. The Wisconsin Archaeologist, Volume 70 (Nos. 1–2, 1989). Monograph of the Mississippi Valley Archaeology Center, University of Wisconsin–La Crosse [Wisconsin Archeological Society, Office of Publication, P.O. Box 1292, Milwaukee, Wisconsin 53201]. Pp. 280. $12.00 (paperbound).

**The Palm—Tree of Life: Biology, Utilization and Conservation.** Michael J. Balick (Editor). Proceedings of the Symposium at the 1986 Annual Meeting of the Society for Economic Botany held at the New York Botanical Garden, Bronx, New York. Bronx: The New York Botanical Garden, and Lawrence, Kansas: Allen Press, 1988. Pp. 282. $53.75 (paperbound). ISBN 0–89327–326–0.

**Ethnobotany of the Chacobo Indians, Beni, Bolivia.** Brian M. Boom. Bronx, NY: The New York Botanical Garden, 1987. Pp. 68. $15.00 (paperbound). ISBN 0–89327–312–0.

**Herbal Dentistry. Herbal Dental Remedies from Ancient Times to the Present Day.** Joseph G. Carter and William J. Carter. Chapel Hill: The University of North Carolina, 1990. Pp. 77 (typescript). $17.95 (softcover). ISBN 0–930989–01–8.

**Folk Dentistry. Cultural Evolution of Folk Remedies for Toothache.** Joseph G. Carter and William J. Carter. Chapel Hill: The University of North Carolina, 1990. Pp. 104 (typescript). $17.95 (softcover). ISBN 0–930989–01–9.

**The Marana Community in the Hohokam World.** Suzanne K. Fish, Paul R. Fish, and John H. Marden (Editors). Anthropological Papers, Number 56. Tucson: The University of Arizona Press, 1992. Pp. 121. Price ? (softcover). ISBN 0–8165–1314–7.

**The Ethnobotany of Southern Balochistan, Pakistan, with Particular Reference to Medicinal Plants.** Steven M. Goodman and Abdul Ghafoor. Fieldiana: Botany: New Series, No. 31, 1992. Pp. v,84. Price ? (paperbound). ISSN 0015–0746.

**The Palaeoethnobotany of Franchthi Cave** by Julie M. Hansen. Fascicle 7 in Excavations at Franchthi Cave, Greece, T.W. Jacobsen, General Editor. Bloom-

ington & Indianapolis: Indiana University Press, 1991. Pp. 280. $45.00 (paperbound). ISBN 0–243–31979–X.

**Agriculture and the Onset of Political Inequality before the Inka.** Christine A. Hastorf. New York and Cambridge: Cambridge University Press, 1993. Pp. xv,298. $69.93 (hardback). ISBN 0–521–40272–7.

**The Tasaday Controversy: Assessing the Evidence.** Thomas N. Headland (Editor). Washington, D.C.: American Anthropological Association Special Publication No. 28. 1992. Pp. xi,255. $19.95 (paperbound). ISBN 0–913167–51–7.

**The State of Nature: Ecology, Community, and American Social Thought, 1900–1950.** Gregory Mitman. The University of Chicago Press, Chicago, Illinois, 1992. Pp. 290. Price ? (clothbound). ISBN 0–226–53236–4.

**Butterflies of the Bulolo-wau Valley.** Michael Parsons. Handbook No. 12 of the Wau Ecology Institute, Wau, Papua New Guinea. Honolulu: Bishop Museum Press, 1991. Pp. 280. $30.00 (paperbound). ISBN 0–930897–61–7.

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**Persephone's Quest: EntheOgens and the Origin of Religion.** R. Gordon Wasson, Stella Kramrisch, Jonathan Ott, and Carl A.P. Ruck. New Haven, Connecticut: Yale University Press, 1986. Pp. 257. $37.00 (clothbound). ISBN 0–300–03877–1.

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Nancy J. Turner
Book Review Editor
*Journal of Ethnobiology*
Environmental Studies Program
P.O. Box 1700
University of Victoria
Victoria, British Columbia
CANADA V8W 2Y2
Phone: (604) 721-6124

## PROJECTS AND PROGRAMS

The **People and Plants** initiative was started in July 1992 by the World Wide Fund for Nature [WWF], the United Nations Educational, Scientific, and Cultural Organization [UNESCO] and the Royal Botanic Gardens, Kew. Through the initiative, these organizations seek to promote the sustainable and equitable use of plant resources by providing support to ethnobotanists from developing countries. People and Plants field personnel organize participatory workshops, make advisory visits, and provide literature on ethnobotany, traditional ecological knowledge, and sustainable plant resource use. Field activities build on work within selected biosphere reserves and World Heritage Sites as well as WWF and Kew projects. For more information contact any one of the three partners: (1) Biodiversity Unit, Conservation Policy Division, WWF International, World Conservation Centre, Avenue du Mont-Blanc, 1196 Gland, SWITZERLAND; FAX 41.22.364–8219; (2) Division of Ecological Sciences, Man and the Biosphere Programme, UNESCO, 7 place de Fontenoy, 75732 Paris CEDEX 07 SP, FRANCE; Fax 33.1.40659897; (3) The Director, Royal Botanic Gardens, Kew, Richmond, Surrey TW9 3AB, UNITED KINGDOM; Fax 44.81.332–5197.

## JOURNALS AND OTHER MEDIA

The **Biological Conservation Newsletter,** edited by Jane Villa-Lobos of the Smithsonian Institution, contains 4–6 pages of short contributed articles; notes on educational materials, new publications, and courses; announcements of meetings and job opportunities; and citations of current literature. It is currently being sent to more than 1,000 people in over 50 countries. To receive the monthly newsletter, contact: Jane Villa-Lobos, c/o Biological Conservation Newsletter, Smithsonian Institution, Department of Botany, NHB 166, Washington, DC 20560; Tel. 1.202.357–2027; Fax 1.202.786–2563.

Volume 1/Number 1 (February 1993) of the **Indigenous Knowledge and Development Monitor** (IK&DM) has just been released. Published in The Hague, the IK&DM is a publication of and for the international community of people who are interested in indigenous knowledge. The IK&DM is produced by the Centre for International Research and Advisory Networks (CIRAN) in close cooperation with the Centre for Indigenous Knowledge for Agriculture and Rural Development (CIKARD), the Leiden Ethnosystems and Development Program (LEAD), and national and regional Indigenous Knowledge Resource Centres. The IK&DM,

which replaces *CIKARD News,* is published three times a year, in two regular issues and one special issue. Issue no. 1, a forty-paged double issue, has already been sent to 3,000 people in 130 countries. Each issue contains articles describing the application of indigenous knowledge in development projects in many parts of the world. A section called Communications includes information on resource centers, networks, research, conferences, databases, and publications. For more information, contact: CIRAN, c/o Nuffic P.O. Box 90734, 2509 LS The Hague, The Netherlands. Telephone 31.70.351-0574; Fax 31.70.351-0513.

The **Forest, Trees and People Newsletter** is a quarterly publication, available in French, English, and Spanish, that provides a forum to discuss social, economic, and political issues of relevance to community forestry. This newsletter is part of the networking actions of the FTP Programme, a multi-donor, FAO-coordinated initiative which supports a wide variety of activities from policy formulation to field projects through regional initiatives in Asia, Africa, and Latin America. The experiences of the programme have been documented in more than 40 publications that are distributed through the network.

Each issue of the newsletter, spanning some 50 to 60 pages, contains numerous articles describing case studies and approaches which can be used to support local farmers' own initiatives to manage their natural resources in a sustainable manner. There are separate sections on information, activities, and events; reviews of literature; editorials and letters. For more information, write: Editor, FTP Newsletter, IRDC, Swedish University of Agricultural Sciences (SUAS), Box 7005, S-75007 Uppsala, Sweden.

## COURSES AND DEGREES IN ETHNOBIOLOGY

A request was made in the last issue of the *Journal* for current information on university-level degree programs and courses in ethnobiology. If you know of any such programs or courses, whether in the United States or in a foreign country, please contact the editor of News and Comments.

## COMMENT

## USE OF POLLEN CONCENTRATIONS IN COPROLITE ANALYSIS: AN ARCHAEOBOTANICAL VIEWPOINT WITH A COMMENT TO REINHARD ET AL. (1991)

by Glenna Dean, *Research Associate Professor, Department of Biology, University of New Mexico, Albuquerque, NM 87131*

### INTRODUCTION

To judge from the phrasing of their article's title, "Use of pollen concentration in paleopharmacology: Coprolite evidence of medicinal plants," Reinhard et al. (1991) proposed to demonstrate prehistoric medicinal plant use in their analysis of pollen spectra from human coprolites by means of pollen concentrations. In actuality, the pollen data were presented in two forms: pollen concentrations and relative frequencies (relative percentages).

Two brief but technical discussions will explore the implications of the choice of pollen analytical method, and some of the perhaps lesser-known aspects of coprolite analysis, before undertaking a re-examination of selected pollen data and some of the authors' original conclusions.

## POLLEN ANALYTICAL TECHNIQUES

Relative frequencies were used by Reinhard et al. (1991) to display and analyze their coprolite pollen data, despite the title of their article. This technique is based on the work of Barkley (1934), Dimbleby (1957), Martin (1963), von Post (1918, 1967), and others. Relative frequencies are obtained by counting the pollen grains in a preparation to a total of 200 (or more), and then dividing the number of grains of each pollen type seen by the total and multiplying by 100. Converting pollen data to relative frequencies has two major effects. One, the conversion of raw data to a standard percentage masks variations of total pollen abundance in the samples being compared. Two, all pollen taxa in a sample increase or decrease in relative frequency in response to a decrease or increase in any other taxon in that sample (Birks and Gordon 1985:11).

Pollen concentrations were cited by the authors only for the total concentration of each sample; these data were not used in any of the analyses they reported. Although not referenced in the article, the concept of determining the concentration of pollen grains/unit of sample is based primarily on the work of Benninghoff (1962) and Maher (1981). The method depends on the addition of known numbers of exotic marker grains (commonly called "spike grains") to samples prior to laboratory extraction; both pollen grains and spike grains are tallied separately during microscopy. Estimation of the actual number of pollen grains present in a unit of sample uses the equation:

$$\#\text{ pollen grains/unit sample} = \frac{\#\text{ fossil pollen counted}}{\#\text{ spike grains counted}} \times \frac{\#\text{ of spike grains added}}{\text{weight (or vol) of sample}} \qquad (1)$$

The method can produce large numbers if pollen in the samples is abundant. The unique strength of the pollen concentration approach is exactly this ability to spotlight different amounts of pollen/unit sample, especially for individual taxa in the pollen spectrum. These numbers can be reduced to percentages, but will round to the same values as when raw pollen counts are divided by the total pollen count to produce relative frequencies, thus losing the particular advantages of scale provided by pollen concentrations.

Both relative frequencies and pollen concentrations are in use today among palynologists to express pollen data. Data from both approaches can be presented for the same set of samples, as done by Reinhard et al. (1991), although this practice may be more common for environmental samples than for archaeological samples.

Generally speaking, three factors influence the pollen spectrum recovered from a sample: rate of pollen production of the contributing vegetation, rate of pollen (and sediment) accumulation at the sampled locus, and rate of degradation at the sampled locus (Stephen A. Hall, personal communication, 1991). Two of

these events, pollen production and accumulation, are crucial to the present discussion.

Environmental palynologists have used relative frequencies to study diachronic vegetation trends in samples from bogs and other open-air sites since the earliest days of palynology, under the fundamental assumption that the pollen rain falling on a given locality is basically uniform from year to year (Birks and Gordon 1985:3–4). Relative frequencies smooth over minor variations in a larger environmental pattern, and are the traditional method of choice for analyzing environmental samples under this theoretical construct. Critical to the success of this approach, however, is the taking of the environmental samples from areas undisturbed by human activities, especially archaeological sites. This is because environmental palynologists recognize that human activities, past and present, disturb the record of environmental pollen rain. Disturbance can take the form of physical turbation of sediments, for example, which can often be seen in the wall of a trench dug for the purpose of sampling. Other past human disturbance may be invisible, such as an alteration of the localized pollen rain as the result of agricultural activities.

Archaeological palynologists, in contrast, take samples to answer research questions about prehistoric human behavior. Archaeological palynology strives to pinpoint past human interference in an otherwise natural pollen rain: differences in rate of pollen accumulation are one clue to such human interference; another is presence of pollen grains of cultivated plants. The best archaeological samples for studying prehistoric human behavior come from enclosed sampling loci such as floors, pits, vessels, and the like. These are sampling loci specifically excluded from environmental pollen rain (commonly viewed as "contamination" or "noise") falling on the open ground. Total numbers of pollen grains in such samples often vary wildly from sample to sample, because human behavior is the primary source of the pollen selectively captured by these sampling loci.

For example, a pit was used to store pollen-dusted seeds or plant parts, in effect accelerating the rate of pollen accumulation there. An adjacent pit was used to store other items, in effect retarding the rate of pollen accumulation there. Both events took place within a pit structure, the roof of which protected the interior from the natural pollen rain of the site area. Samples scraped from the bottom of both pits will yield pollen spectra skewed not only in terms of total pollen abundance, but also in favor of individual pollen taxa. This is the beginning of a picture of prehistoric human behavior in connection with the two pits, but the choice of data presentation, relative frequencies or pollen concentrations, will determine what patterns are actually seen by the analyst.

Pollen concentrations will highlight differences in pollen accumulation between the samples in this example. These differences in pollen accumulation will be lost if data are expressed as relative frequencies. Perhaps more importantly, rare pollen taxa can be analyzed as real numbers/unit of sample when expressed as pollen concentrations because the data need not sum to a predetermined total such as 100%. Rare pollen taxa can only reflect 1% or less of a 200-grain count when expressed as relative frequencies. It is this lack of ability to highlight rare pollen taxa that is the greatest shortfall of relative percentages as applied to archaeological samples taken to answer human behavioral questions.

## POLLEN IN HUMAN COPROLITES

Pollen grains enter the body by inhalation from the air and by ingestion via beverages and food. The rate at which pollen grains and other items exit the human system is another matter. Modern experimental data (Alvarez and Freedlander 1924; Kelso 1976; Martin 1965; Williams-Dean 1978) have shown that intestinal motility is not constant from individual to individual, nor in one individual from day to day. In order for coprolite analysis to proceed at all, a number of basic assumptions are made; it is recognized that they are a gross oversimplification of demonstrated variability.

It is assumed that the pollen spectrum passing through a person's system varies from day to day. The recovery of large amounts of pollen from more than one coprolite implies that large amounts of pollen were ingested for more than one day (assuming that all the coprolites under study were deposited over time, and not as one single event). The natural windborne pollen rain should cause a relatively uniform concentration of "background" pollen types, because they are seasonally present in the air for more than one day. The ingestion of windborne and insectborne pollen types with food and drink, on the other hand, should produce a pollen assemblage independent of the windborne pollen rain.

Coprolite analysts are more or less forced to describe pollen from coprolites as resulting from "accidental" or "incidental" ingestion as opposed to "purposeful" or "economic" ingestion because of limitations in the English language. It is assumed that pollen was probably rarely ingested as a recognized substance per se. The distinction to be made is whether pollen was inhaled or ingested in pollen-dusted water or other liquid (incidental ingestion), or whether pollen accompanied the deliberate ingestion of plant material that happened to be pollen-bearing (economic or purposeful ingestion). Pollen resulting from so-called purposeful ingestion is viewed as indicating dietary, medicinal, or other behavior involving the parent plant. Unusual pollen abundance is one clue to an economic use of plants; presence of insectborne pollen types is another, because these types are rare or absent in the atmospheric pollen rain. In order to establish some sort of baseline for comparison, samples from the air or the modern ground surface are analyzed to provide an idea of pollen production in the site area (expressed as pollen con-centration/unit of sample); these figures provide an idea of how many pollen grains are available to be accidentally inhaled by local residents today (and in the past, by extension).

It is apparent that human coprolites are very far removed from the traditional environmental concept of a "uniform pollen rain," and constitute instead an extreme class of archaeological pollen samples influenced by idiosyncratic human behavior. This means that if the ingestive behavior of individual people is to be studied, then a technique which focuses on different pollen accumulation will give better data.

## THE BEHAVIORAL ANALYSIS OF HUMAN COPROLITES

Reinhard et al. (1991) chose to analyze the pollen present in coprolites, the ultimate behavioral samples, using methods designed for environmental palynology and its assumptions (for the record, my own work with prehistoric and

TABLE 1.—Approximate pollen concentrations, in number of pollen grains/g of sample, of Bighorn Cave coprolites.

| Concentration[1] | Lab No. | *Ephedra* | % | *Salix* | % | *Larrea* | % |
|---|---|---|---|---|---|---|---|
| 0 | 12 | — | — | — | — | — | — |
| 14,300 | 1 | 429 | 3 | 572 | 4 | 143 | 1 |
| 16,100 | 2 | 322 | 2 | 322 | 2 | — | — |
| 17,100 | 17 | 171 | 1 | 1,710 | 10 | 171 | 1 |
| 20,500 | 14 | 410 | 2 | — | — | 820 | 4 |
| 26,000 | 6 | — | — | 520 | 2 | 780 | 3 |
| 26,200 | 5 | 524 | 2 | 524 | 2 | 262 | 1 |
| 29,300 | 9 | 879 | 3 | 4,395 | 15 | — | — |
| 29,400 | 3 | — | — | 1,176 | 4 | 588 | 2 |
| 36,300 | 10 | 726 | 2 | 363 | 1 | 1,452 | 4 |
| 53,000 | 13 | 530 | 1 | 530 | 1 | 2,650 | 5 |
| 72,300 | 4 | 4,338 | 6 | 1,446 | 2 | — | — |
| 114,900 | 7 | — | — | — | — | — | — |
| 129,000 | 18 | 3,870 | 3 | 2,580 | 2 | — | — |
| 150,000 | 8 | — | — | 1,500 | 1 | — | — |
| 224,000 | 11 | — | — | 192,640 | 86 | — | — |
| 1,137,000 | 16 | — | — | 693,570 | 61 | — | — |
| 2,240,000 | 20 | 1,680,000 | 75 | 22,400 | 1 | 67,200 | 3 |
| 2,340,000 | 21 | 1,895,400 | 81 | — | — | 46,800 | 2 |
| 4,973,000 | 15 | — | — | 4,973,000 | 100 | — | — |
| 5,000,000 | 19 | — | — | — | — | — | — |
| means of 21 samples | | 170,838 | 8.6 | 280,821 | 14.0 | 5,756 | 1.2 |

[1]"Total concentration" (column 1) and relative frequencies taken from Reinhard et al. (1991:123). Approximate concentration values for each taxon calculated from relative frequencies as follows: total concentration × relative frequency of a taxon = concentration for that taxon

modern coprolites also used relative frequencies to express the pollen data [Williams-Dean 1978]; this work is slated for revision). It is my position that use of relative pollen frequencies has resulted in behaviorally meaningful patterns being missed in coprolite pollen data.

I converted the relative frequency data presented by Reinhard et al. (1991) to pollen concentrations by multiplying total concentration by the relative frequency for each pollen taxon, yielding a close approximation of the actual pollen concentrations (Table 1, 2). Original relative frequency values are included for sake of comparison; note that low relative frequencies actually mask high pollen concentrations in many instances. As explored in the following discussion, converting the data for each pollen taxon to pollen concentration provides a much richer picture of prehistoric plant use in each sample.

Reinhard et al. (1991) chose to spotlight three genera of plants with known ethnopharmacological uses: *Larrea* (creosote bush), *Salix* (willow), and *Ephedra* (Morman tea). Data on other pollen types recovered from the coprolite specimens were largely omitted. Only the pollen data from Bighorn Cave, Arizona, and the

TABLE 2.—Approximate pollen concentrations, in number of pollen grains/g of sample, of NAN Ranch burial coprolite and burial soil samples.

| Taxon | Burial Coprolite | % | Burial Soil 1° | % | Burial Soil 2°° | % | Burial Soil 3°°° | % |
|---|---|---|---|---|---|---|---|---|
| *Salix* | 117,000 | 26 | 93 | tr | — | — | — | — |
| Apiaceae | 2,250 | tr | 93 | tr** | — | — | — | — |
| *Artemisia* | — | — | — | — | 63 | tr* | — | — |
| Brassicaceae | 238,500 | 53 | — | — | — | — | — | — |
| Cactaceae | — | — | 186 | 1 | 63 | tr | — | — |
| *Cucurbita* | 4,500 | 1 | — | — | — | — | — | — |
| Cheno/Am | 36,000 | 8 | 13,020 | 70 | 7,056 | 56 | 3,886 | 58 |
| Fabaceae | — | — | — | — | — | — | 34 | tr |
| high-spine aster | — | — | — | — | 63 | tr* | — | — |
| low-spine aster | 2,250 | tr | — | — | 63 | tr | 67 | 1* |
| *Pinus* | — | — | 744 | 4 | 63 | tr | 201 | 3 |
| Poaceae | 4,500 | 1 | 2,046 | 11 | 2,142 | 17 | 804 | 12 |
| *Typha* | 4,500 | 1 | — | — | — | — | — | — |
| unidentifiable | 2,250 | tr | 744 | 4 | 63 | tr*** | 469 | 7 |
| *Zea* | 45,000 | 10 | 1,674 | 9 | 2,646 | 21 | 1,206 | 18 |
| TOTALS: | | | | | | | | |
| Pollen counted | 1,011 | | 209 | | 211 | | 124 | |
| Concentration | 450,000 | | 18,600 | | 12,600 | | 6,700 | |

tr trace (here assumed to be a uniform 0.5%).
* trace % reported for Burial Soil 1 by Shafer et al. (1989:22; Sample 2).
** trace % reported for Burial Soil 2 by Shafer et al. (1989:22; Sample 3).
*** trace % reported as 5% in Shafer et al. (1989:22); concentration value would equal 630 grains g.
° provenience given as "grave fill" (Shafer et al. 1989:22; Sample 2).
°° provenience given as "soil from atop left pelvis" (Shafer et al. 1989:22; Sample 3).
°°° provenience given as "soil from beneath pelvis" (Shafer et al. 1989:22; Sample 4).

Values do not necessarily sum to total. Approximate concentration values calculated as in Table 1. "Total pollen grains counted" taken from Shafer et al. (1989:22). "Total pollen concentration" taken from Reinhard et al. (1991:127).

NAN Ranch, New Mexico, are addressed here, since the Texas samples discussed by Reinhard et al. (1991) did not have pollen concentration values available for their pollen spectra. The conclusions from Reinhard et al. (1991) and my reanalysis are summarized and compared in Table 3.

*Bighorn Cave data.*—The authors stated as an underlying assumption that insect-borne pollen types were to be viewed as signalling ". . . the intentional consumption of dietary or medicinal plants" (page 122) only when present in relative frequencies greater than 4%. To further highlight intentional consumption of pollen grains, the authors calculated the mean occurrence of the three pollen taxa under discussion (*Larrea, Salix,* and *Ephedra*) for all 21 Bighorn Cave coprolites; these means were calculated on the basis of relative frequencies, not pollen concentration values.

TABLE 3.—Comparison of conclusions: relative frequencies vs. pollen concentrations

| Bighorn Cave Relative Frequencies | Bighorn Cave Pollen Concentrations |
|---|---|
| (1) *Larrea* pollen was accidentally ingested in the 10 specimens in which it was seen (mean of relative frequencies was below 4%). | (1) *Larrea* pollen was not accidentally ingested (relative frequencies represent from 143 to over 67,000 insect-transported *Larrea* pollen grains/g of sample). |
| (2) *Salix* pollen frequencies were significant in only three of 16 samples containing *Salix* (relative frequencies were above the mean of 14%). | (2) *Salix* pollen concentrations were significant (above an arbitrary 1000 grains/g) in 10 of 16 samples containing *Salix*. Experimental data are needed to suggest the number of *Salix* pollen grains available for accidental ingestion. |
| (3) Relative frequencies of *Ephedra* in samples from the modern ground surface were 8%–45%, suggesting that windborne *Ephedra* pollen was accidentally ingested or inhaled in 10 of 12 samples containing *Ephedra*. | (3) Concentration values of *Ephedra* in two New Mexico samples from the modern ground surface suggest that windborne *Ephedra* pollen might have been accidentally ingested or inhaled in only 8 of 12 samples containing *Ephedra*. Better data are needed from modern plant communities. |
| **NAN Ranch Relative Frequencies** | **NAN Ranch Pollen Concentrations** |
| (1) Control samples from the midden contained more pollen from Cheno/Ams, Poaceae, and low-spine Asteraceae than did the coprolite, indicating that the lower amounts of these pollen types in the coprolite were derived from the natural pollen rain in the site area. | (1) The coprolite sample contained more pollen from Cheno/Ams, Poaceae, and low-spine Asteraceae than did the samples from the midden, despite the midden's exposure to the atmospheric pollen rain, indicating that the coprolite pollen spectrum is behavioral in origin. |
| (2) Midden samples contained more pollen from corn than did the coprolite, pointing up the unusual nature of the last meal(s) of the individual. | (2) The coprolite sample contained more pollen from corn than did the midden samples; no unusual last meal(s) are indicated in the coprolite pollen spectrum. |
| (3) The pollen spectra of the three midden samples resembled each other more than the coprolite pollen spectrum; these were lumped and interpreted as environmental or non-behavioral control samples. High relative frequencies of *Zea* pollen in samples 2 and 3 were suggested as reflecting ritual preparation of the grave with corn pollen or corn meal by Shafer et al. (1989:27), but not by Reinhard et al. (1991). | (3) Burial Soil Sample 2, taken from atop the left pelvis, contained up to twice as many grains of *Zea* pollen as the other two midden samples, suggesting that the sample reflected decomposed intestinal contents. The concentrations of *Zea* pollen in the other two midden samples reflect localized deposition of pollen-bearing plant material which may predate the grave, or may have resulted from ritual use of corn products in the grave as suggested by Shafer et al. (1989:27). |

The mean percentage of *Larrea* (1.2%) is below the stated threshold of 4% and all *Larrea* data from the coprolites were dismissed by Reinhard et al. (1991) as ". . . accidentally ingested" (page 125). However, when pollen concentration values of *Larrea* are calculated and the mean determined from these data, samples 20 and 21 (67,200 and 46,800 grains/g, respectively) depart significantly from the mean (5,756 grains/g), suggesting more than accidental ingestion of *Larrea* pollen (Table 1). In fact, most of the calculated concentration values for insectborne *Larrea* pollen grains appear to be high enough to indicate intentional ingestion regardless of departure from the mean concentration value. Pollen concentration data from modern surface samples are needed to establish an "environmental" or "natural" baseline from which to infer "behavioral" departures.

My calculation of concentration values and the mean for *Salix* pollen data from Bighorn Cave coprolites indicates that only two samples (samples 15 and 16), not three (samples 11, 15, and 16) as determined by the authors, depart from the mean concentration value of 280,821 grains/gram (Table 1). The calculated concentration value for Sample 11 (192,640 grains/gram) is still very large; I would definitely pay attention to it if I were conducting this analysis *de novo*. In fact, given the sampling context (coprolites), most of the calculated concentration values for insectborne *Salix* pollen appear to be high enough to indicate possible intentional ingestion.

At this point, I suggest that it is inappropriate to apply analyses of central tendencies and departures from a mean to samples from coprolites precisely because the pollen spectrum originates from within a human body with an idiosyncratic rate of pollen introduction. Given the context, establishment of a mean implies nothing more than an average level of *ingestion*. Coprolites completely lacking pollen are not unknown; one such occurs among the Bighorn Cave samples, raising questions about the implications of both pollen-negative and pollen-positive coprolites. The point of coprolite pollen analysis is to distinguish pollen grains which just "blew into their mouths" from pollen grains which were swallowed more intentionally. A more reasonable approach than analyzing central tendencies is to measure normal ambient pollen levels by means of samples from the modern ground surface or of airborne pollen, using those pollen concentrations as baselines with which to compare coprolite pollen concentrations.

In just such a support of their evaluation of the *Ephedra* frequencies, Reinhard et al. (1991:126) cited the spectra of five modern surface pollen samples taken in an *Ephedra*-dominated ecosystem near Corpus Christi. Those relative frequencies ranged from 8% to 45%; corresponding concentration values were not given. By way of comparison, my own surface sampling of vegetation communities in New Mexico (which include *Ephedra* as a minor member) indicates that the time of year during which the sample is taken is critical. Samples taken during the pollination season for this wind-pollinated plant yield nearly double the calculated pollen concentrations of samples taken at the same locations several months later (Dean 1991; 2723 *Ephedra* grains/g in June 1990; 1528 *Ephedra* grains/g in September 1990). Corresponding relative frequencies for these concentration values are 12% and 7% respectively. If, for the sake of argument, we use my high value as a trial maximum for the normal pollen rain in a vegetation community in which *Ephedra* is present but not dominant (as proposed by Reinhard et al. [1991:125–126] for the West Texas area), four Bighorn Cave samples, not two, contain significant con-

centration values (samples 4, 18, 20, and 21; Table 1). Obviously, more modern pollen samples are needed from well-described vegetation communities in the area of each archaeological site to establish the range of *Ephedra* (and other) pollen concentrations released into the air to be ingested by local residents.

*NAN Ranch data.*—Reinhard et al. (1991) also presented and discussed pollen data from one coprolite and three soil samples from a midden burial context at the NAN Ranch in New Mexico. The pollen spectra of these four samples had been previously included in discussions by Shafer et al. (1989). I calculated pollen concentration values for the various pollen taxa as described earlier, using data provided in Reinhard et al. (1991; Table 5) and Shafer et al. (1989; Table 1). I assumed that "trace" uniformly indicated 0.5% (1 pollen grain in a 200-grain count) of the stated pollen spectrum. This means that some of my calculations for "trace" percentages probably vary from the actual abundances of rare pollen types. My calculated pollen concentrations are presented in Table 2.

Data given by Shafer et al. (1989:22) indicated that three soil samples were taken from grave fill (here, Burial Soil Sample 1), from atop the left pelvis (here, Burial Soil Sample 2), and from beneath the pelvis (here, Burial Soil Sample 3). This suggests that Burial Soil Sample 2 from atop the pelvis may also contain pollen originating from within the abdomen of the body. Reinhard et al. (1991) lumped all three soil samples together as control samples. These authors observed that pollen frequencies were dominated by Cheno/Am (goosefoot and pigweed) and Poaceae (grass) pollen types, and concluded that these reflected the natural pollen rain of the site area (Reinhard et al. 1991: 126–127), but it should be noted that relative frequencies for Burial Soil Sample 3 are based on an incomplete count (124 pollen grains; Shafer et al. 1989:22). The lower frequencies of Cheno/Am and Poaceae pollen types in the coprolite received no further attention.

Converting relative frequencies of the four samples to concentrations shows that windborne Cheno/Ams and Poaceae are actually more abundant in the burial coprolite than in the control samples. In fact, low-spine Asteraceae (wind-pollinated sunflowers) and *Zea* (corn) pollen types are also more abundant in the coprolite, in contradiction of the pattern yielded by the relative frequencies. The spectrum of Burial Soil Sample 2 from atop the pelvis contains the second highest number of *Zea* pollen grains (up to twice that of the other soil samples), suggesting that it indeed may reflect decomposed intestinal contents. These observations are despite the fact that the sediments into which the grave was dug must have been exposed to the natural pollen rain of the site area while midden deposits were accumulating. The observation that more pollen grains were introduced into a human digestive tract than were accumulated by a midden highlights the special nature of coprolites as data sources; those extra pollen grains may or may not have been knowingly ingested by the individual, but it is very unlikely that they originated from the natural pollen rain of the site area. Concentrations of *Zea* pollen in midden samples 1 and 3 reflect localized deposition of pollen-bearing plant material, and may have resulted from ritual use of one or more corn products in the grave as originally suggested by Shafer et al. (1989:27).

The picture of pollen abundance in the burial coprolite as reflected by concentration values indicates that the individual consumed Cheno/Am, Poaceae,

and *Zea* pollen (probably along with ground chenopod and grass seeds and one or more ground corn products), and the pollen of low-spine Asteraceae (possibly as part of a tea such as made from blooming *Thelesperma* [Navajo tea or *cota*] in the greater Southwest to this day), and the pollen of *Salix* (possibly as a medicinal tea or a fresh food source in the early spring). The burial coprolite had been previously interpreted as reflecting a special diet (Shafer et al. 1989), primarily on the basis of the lack of fiber content. Given that many post-Archaic coprolites were found to be fiber-free in the studies cited by Shafer et al. (1989), there would appear to be little in either the macrofossil or pollen portions of the NAN Ranch coprolite to support the suggestion that it resulted from an unusual diet.

## POLLEN EVIDENCE OF MEDICINAL USES OF PLANTS

Reinhard et al. (1991) further concluded that presence of large frequencies of *Salix* and *Ephedra* pollen in some coprolites was the result of intentional consumption of (medicinal) teas (the low frequencies of *Larrea* pollen grains had been dismissed as "accidentally ingested" as noted earlier). This conclusion followed from their observations that the coprolites contained high frequencies of disaggregated pollen grains and lacked botanical macroremains. Because flowers usually contain anthers, and anthers produce pollen, the lack of pollen aggregates in the study coprolites was interpreted to mean that *floral* material was not directly consumed (page 127), but the supporting discussion is confused (". . . *flowers* of this plant were intentionally consumed, probably in a tea derived from the *foliage* of the plant" [page 129], and, "In the process of soaking and possibly heating vegetative and *floral structures* in water, the light pollen grains floated into solution and were then drunk. An aqueous solution derived from *foliage* was the probable source of large amounts of pollen . . ." (page 128, emphasis added). Medicinal use of teas was ascribed to the pollen data because of ethnopharmacological records for these taxa (page 119).

*Salix* is a dioecious genus (Correll and Johnston 1979:448), with completely separate male and female plants; *Ephedra* is usually dioecious (Correll and Johnston 1979:80). Ingestion of unpollinated female flowers of either *Salix* or *Ephedra* would yield no pollen grains to a coprolite. Ingestion of foliage, bark, or stems from female plants would similarly leave no pollen evidence of the use of these plants, unless pollen from male plants had been deposited on the gathered plant material. Presence of pollen implies the use of primarily male flowers and male plants, and secondarily the use of fertilized female flowers and pollen-dusted female plants. Male and female *Salix* plants produce precocious catkins before or at the beginning of leaf formation, and flowers are unlikely enough to be found in the field that separate keys have been devised for vegetative and floral characters (Correll and Johnston 1979:449–451). Ingestion of male or fertilized female flowers would result in the appearance of *Salix* pollen grains in coprolites. Taxonomic evidence indicates that there is a limited time frame for *Salix* foliage to be produced and still accumulate *Salix* pollen; plant material gathered for use during any other time of year would be very unlikely to convey *Salix* pollen grains in the numbers recovered from either the Bighorn Cave or the NAN Ranch samples. This proposition should be confirmed by laboratory experiments using *Salix* foliage

gathered from male and female plants during the pollination season as well as later in the year.

Why the lack of pollen aggregates which should have been present in the anthers of male flowers and on the fertilized female flowers? At least two possible solutions present themselves. Casual inspection of pollen data from my own work and the work of other palynologists reveals that aggregates of many pollen types are unusual no matter what the sample context. This is to say, pollen taxa such as Cheno/Ams and low-spine Asteraceae are commonly seen as aggregates while most other pollen taxa are rarely seen as aggregates. This suggests that a lack of pollen aggregates is more likely a reflection of plant reproductive biology than human behavior. The presence of pollen aggregates, on the other hand, is cause for scrutiny. Lack of aggregated *Ephedra* pollen grains in the coprolites is a perfect illustration of this point, because it is a wind-pollinated taxon and pollen grains are produced with a minimum of sticky coatings in order to enhance transportation from one plant to another. I can recall seeing aggregates of *Ephedra* pollen only once in 15 years of pollen analysis, but male *Ephedra* flowers should be tested in the laboratory to see whether they yield pollen aggregates.

Secondly, use of a four-minute sonication as part of the pollen extraction procedure may be especially pertinent for *Salix* (sonication ". . . separates the microscopic particles," Reinhard et al.(1991:120). It is entirely possible that this treatment disrupted pollen aggregates from male or pollinated female flowers without causing other damage that would be recognized at the microscope. A simple experiment to extract pollen from male *Salix* flowers with and without a four-minute sonication would shed light on this issue. Disaggregation of pollen aggregates in hot tea water, as suggested by Reinhard et al. (1991:128), is unlikely. Hot water washes are a common part of my pollen extraction procedures and aggregates of other pollen types, both wind- and insect-transported, are common in the final pollen preparation (I have no data specifically for *Salix*). In the final analysis, lack of pollen aggregates does not in and of itself support the interpretation that medicinal teas were the source for the pollen grains under discussion.

Medicinal purposes for *Salix* flowers were lacking in the ethnographic sources I consulted (Castetter and Bell 1951:202–203; Elmore 1976:185; Moore 1979:161; Tierney 1983:70; Vines 1986:95, 104). Only twigs and bark were described for medicinal purposes; these were administered internally as a tea or externally as a wash. Castetter and Bell (1951:203) mentioned that ". . . a fine drink . . ." was formerly made of *Salix* flowers by the Yuma Indians on the Colorado River, but no medicinal effects were mentioned for this drink, nor whether male or female flowering catkins (or both) were selected for use, nor was the preparation (by infusion, fermentation, or another method that might affect the amount of pollen present in the final drink) described. Lack of an ethnographic reference for a particular use for a particular plant does not, of course, mean that the plant never enjoyed such a use. Lack of an ethnographic reference, however, would suggest caution in the conclusion of a "new" use in prehistory.

*Salix* and *Populus* are closely related members of the same plant family; indeed, some forms cannot be easily distinguished. Food uses of *Salix* flowering catkins were lacking in the ethnographies I consulted, but cottonwood *(Populus)* flowering catkins were eaten during February and March as one of the very ear-

liest spring wild foods in Arizona and New Mexico (Castetter 1935:43). In this dioecious genus, the male catkins are conspicuous but the female catkins are not. Elmore (1943:37–39) states that the Navajo chew *Populus* catkins as gum, alone or mixed with animal fat, and notes that the Navajo words for the flowering catkins of both *Populus* and *Salix* are identical. This observation suggests at least one native taxonomy that lumps uses of both plants together, raising the possibility that such nonmedicinal uses for *Populus* catkins as food or chewing gum could reasonably have extended in the past to include the catkins of closely-related *Salix*.

Finally, Reinhard et al. (1991:130) suggested that *Ephedra* teas may have been used to relieve stuffy noses and colds. However, they stated earlier (page 119) that North American species of *Ephedra* do not contain ephedrine, the compound used to treat such symptoms and found only in Old World species of *Ephedra*.

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## RESPONSE

## THE UTILITY OF POLLEN CONCENTRATION IN COPROLITE ANALYSIS: EXPANDING UPON DEAN'S COMMENTS

by Karl J. Reinhard,
*Department of Anthropology, University of Nebraska–Lincoln,*
*126 Bessey Hall, Lincoln, NE 68588–0368*

Glenna Dean presents a variety of comments on recent research into coprolite evidence of medicinal plants (Reinhard et al. 1991). Some of her comments provide a different perspective on the ethnobotanical significance of our finds. Other comments address methodological issues. The breadth of her comments prevents me from addressing all in a single response; consequently I will focus on those that are more stimulating to me.

Dean comments on two papers, Reinhard et al. (1991) and Shafer et al. (1989); the latter was published in the *Journal of Field Archaeology* and I will largely ignore the comments regarding it. Concerning Reinhard et al. (1991), Dean's comments about plant ecology, pollen dispersion, ecological sampling, and the ethnographic literature were considered by us, and some of these issues were addressed in the original paper. Consequently I will not address them again although I recognize that Dean's alternative interpretations are valid.

Dean's comments of greatest value to me regard the interpretation of pollen concentration data. Dean's observations on this issue provide a stimulating departure for further exploration of the pollen concentration technique. I take this opportunity to place her comments within the perspective of coprolite methodology and to expand upon her observations.

Although pollen analysis of coprolites has long been used for dietary reconstruction, it is a technique that is undergoing continuing refinement (Reinhard and Bryant 1992). A major goal of such analysis is separating the dietary compo-

nent of coprolite pollen data from the nondietary. Using relative frequency data, several researchers have addressed this issue with some success (Bohrer 1981; Bryant 1974a, 1974b; Bryant and Williams-Dean 1975; Clary 1984; Scott 1979; Williams-Dean 1978). Furthermore, the intestinal passage of pollen has been examined experimentally by Kelso (1976) and Williams-Dean (1978) which greatly elucidated the nature of pollen transport and deposition from ingestion to defecation.

Pollen concentration is the latest development of coprolite pollen analysis. The pollen concentration technique was originally devised by stratigraphic palynologists as a means of determining absolute pollen content per unit of sediment and now has recognized potential in paleoethnobotanical analysis (Bryant and Holloway 1983; Holloway and Bryant 1986; Pearsall 1989). Although Kelso (1976) applied the technique in his study of modern feces, Aasen (1984) was the first to apply it to coprolites, followed by Sobolik (1988). Most recently, methods for its application to latrines have been defined by Warnock and Reinhard (1992). Although I had been involved in coprolite pollen analysis since the early 1980s (Reinhard 1985), I did not begin to apply the pollen concentration technique consistently until 1986 with an analysis of Archaic coprolites in southwest Texas (Reinhard et al. 1993). Since then, I have collected pollen concentration data from 155 coprolites from Archaic and horticultural sites in the Southwest and am collecting similar data from Mesoamerican and Peruvian coprolites.

I suspected that application of pollen concentration data to coprolites might provide insight into dietary behavior. In Reinhard et al. (1991) a case was presented that pollen concentrations, when combined with relative pollen frequency data, help shed light on use of medicinal plants, an aspect of plant use which is cryptic in the archaeological record relative to dietary plant use. However, we were conservative in our approach and suggested that pollen concentration be applied as one of a battery of tests, including relative pollen frequency and statistical evaluation, to determine with greater certainty whether human behavior affected pollen recovered from coprolites. Multiple tests of an archaeological problem minimize the possibility of making an interpretive error. Relative frequency data and pollen concentration data both reflect human use of plants, but the magnitude of pollen concentrations from coprolites provide unequivocal evidence of human utilization of economic taxa. We were, however, concerned about applying a stratigraphic technique to archaeological coprolite analysis. There are potentially undefined factors of human behavior and intestinal physiology that may profoundly affect pollen concentration data as has been suggested by Kelso (1976) and Dean (Williams-Dean 1978).

Dean's new comments are significant contributions to the application of the pollen concentration technique. She suggests that pollen concentration data tell us more about plant use than relative frequency data. This suggests that pollen concentration data can be presented independently of relative frequency data. If correct, Dean has made a breakthrough in refining pollen analysis of coprolites. I test her assertion by presenting preliminary statistical evaluation of pollen values from coprolites (further statistical studies are planned). Dean highlights coprolite-specific factors that affect pollen content based on her work with modern feces. I expand on this point by describing recent results of examining mummy intestinal contents which further point to factors of ingestion and food type that affect

pollen concentration. Another issue raised by Dean relates to the utility of pollen aggregates as indicators of pollen consumption. She also suggests that pollen extraction technique may destroy pollen aggregates. I address this issue with data derived from pollen extractions of coprolites using different techniques.

## POLLEN CONCENTRATIONS VERSUS RELATIVE FREQUENCY

Pollen data have long been presented by coprolite researchers as relative frequency expressions of a minimum of 200-grain counts. If a new technique is to be useful, it must provide information not available through previous approaches. Statistical analysis of relative pollen frequencies and pollen concentration values should discern whether or not pollen concentration provides different information than relative frequencies.

Dean intuits that pollen concentration values provide a more complete picture of plant utilization than do relative frequencies. Although I agree, I wonder whether the two approaches provide results which are statistically different. Both are measures of pollen abundance and as such may simply represent two different avenues to the same conclusion. For example, if relative frequency shows that a given pollen type makes up 90% of the pollen from a gram of coprolite and the pollen concentration value shows that it occurs in 1,000,000 grains per gram of coprolite, then both expressions indicate a high percentage and high human usage. The difference is the magnitude of pollen variation. Relative frequency data are normalized within 1–100% limits while concentration values typically range between 0 to several million. Thus, the difference, if any, in information conveyed by the two techniques results from differences in magnitude of the different expressions.

To evaluate the difference between the two expressions, I compared relative frequency and concentration value data for 20 coprolites, 10 from the hunter-gatherer site Bighorn Cave, Arizona, and 10 from the horticultural site Salmon Ruin, New Mexico. I selected these sites because of clear differences in the nature of pollen yield between them. Salmon Ruin coprolites tend to contain fewer pollen types, a generally high amount of pollen per coprolite, and lessened background pollen representation. The reverse is true for Bighorn Cave.

The coefficient of variation was determined for each pollen taxon by site. If there is different information being conveyed by pollen concentration as opposed to relative frequency data, then one would expect that when the coefficients are plotted against each other, they would deviate from a linear distribution. As shown in Fig. 1 and Fig. 2, the two sites show variable patterns of coefficient correlation. Salmon Ruin coefficients show poor correlation ($R^2 = 0.50$); Bighorn Cave data show a strong correlation ($R^2 = 0.87$). These results indicate that the two techniques do provide different information, but that the extent of difference is related to site.

Why is this the case? Pollen from Bighorn Cave is largely derived from background taxa, whereas at Salmon Ruin pollen is largely derived from dietary plants. It would therefore appear that human usage of plants could account for the variation. The higher magnitude of variation exhibited by pollen concentration data is probably related to the higher magnitude present in the raw pollen concentration values.

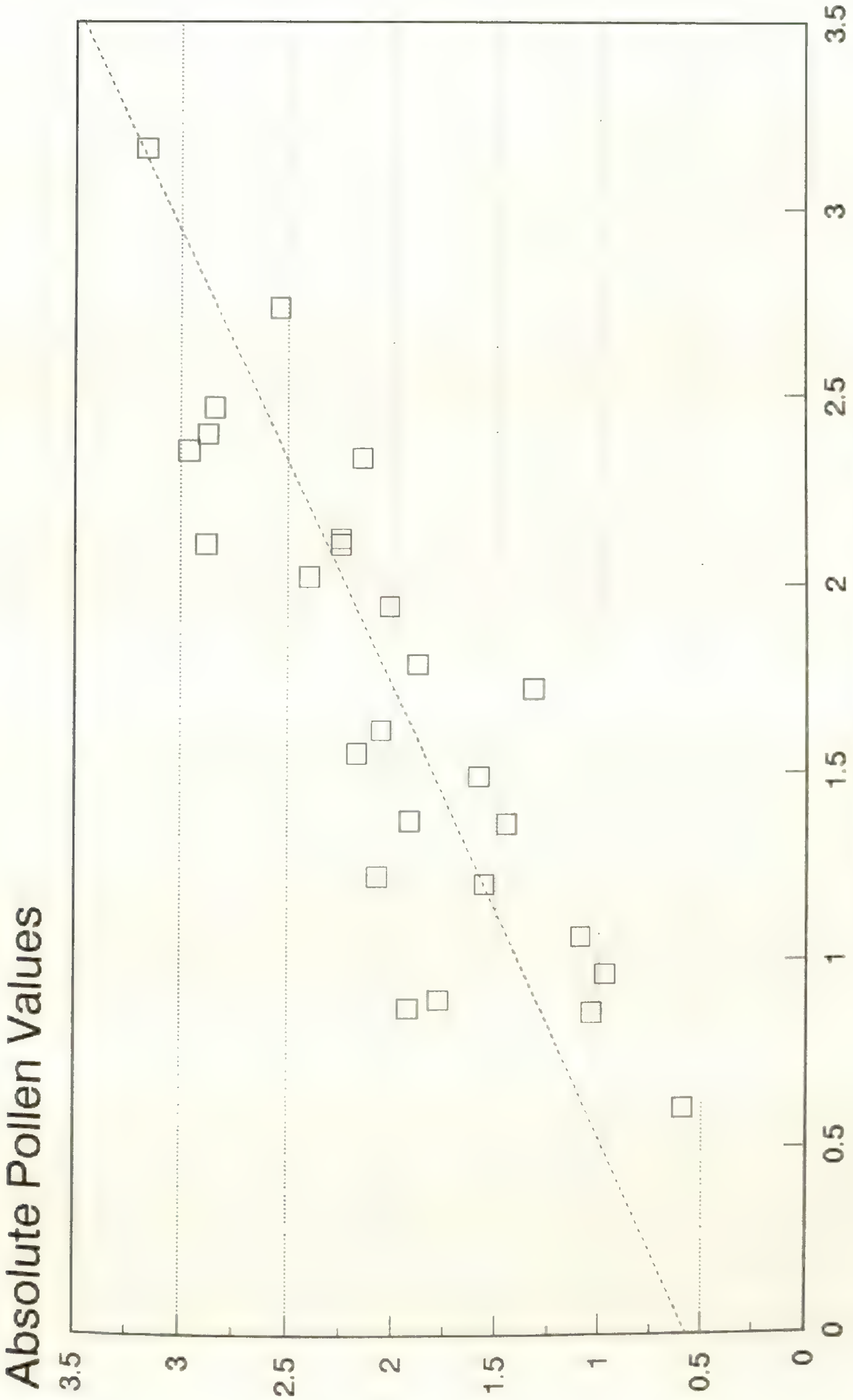


FIG. 1.—Coefficients of variation of pollen concentration and relative frequency values for taxa recovered from Bighorn Cave coprolites. A strong correlation ($R^2 = 0.87$) indicates little difference in the nature of data provided by the two types of pollen quantification.

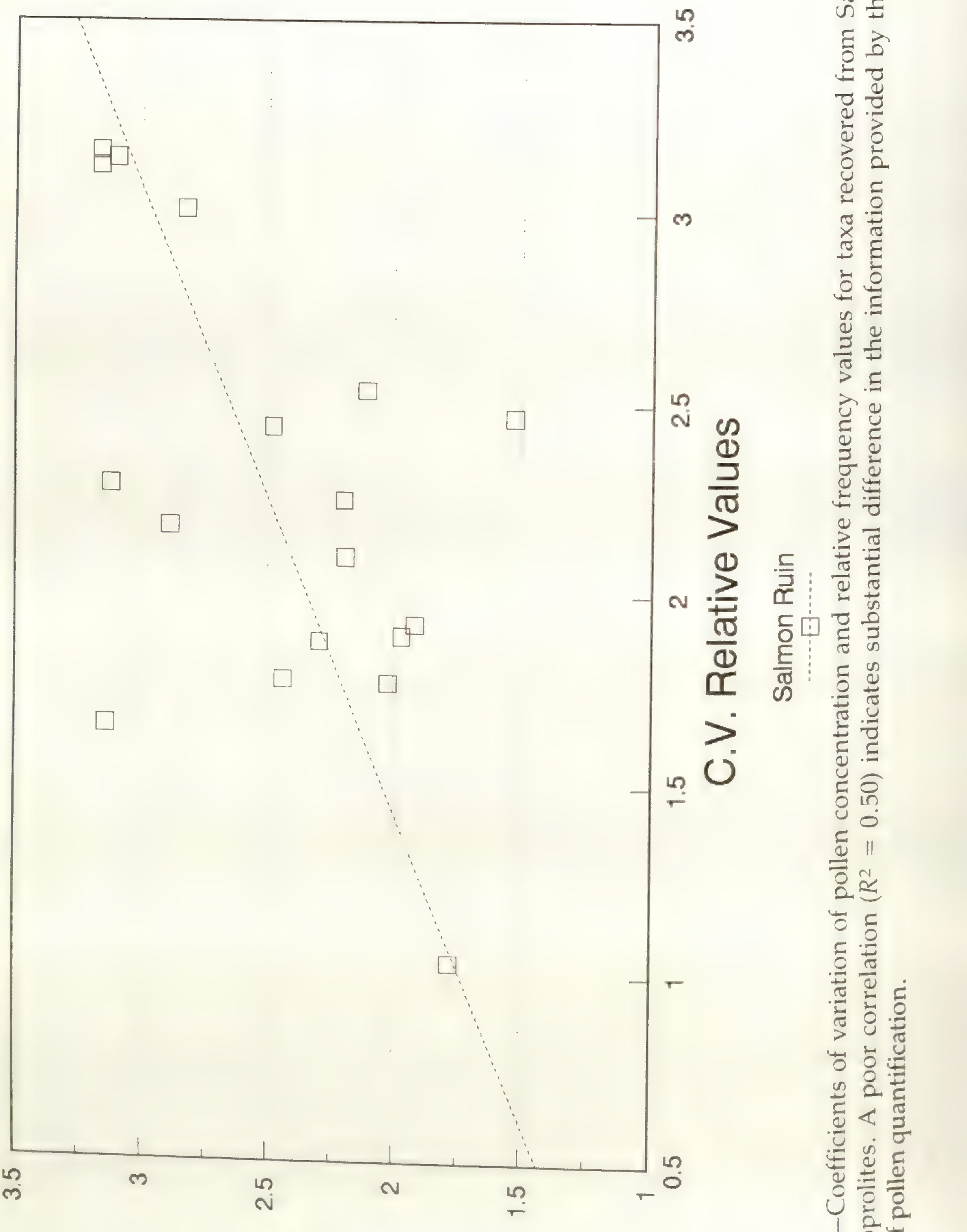


FIG. 2.—Coefficients of variation of pollen concentration and relative frequency values for taxa recovered from Salmon Ruin coprolites. A poor correlation ($R^2 = 0.50$) indicates substantial difference in the information provided by the two types of pollen quantification.

Finally, to test whether there is different information conveyed on a population level, cluster analysis was performed on pollen concentration and relative frequency data from each site. With regard to Bighorn Cave, the same nine samples sorted into one cluster while one was sorted into another for both concentration and relative frequency data. Clustering differed for Salmon Ruin in that one sample was sorted out in the pollen concentration value analysis but another was sorted out in the relative frequency analysis. This indicates that the different techniques provide different statistical information. Further analysis of the relative significance between pollen frequency and pollen concentration needs to be done; we are continuing to evaluate this problem for the sites mentioned above.

A difference in the information gained by applying the two techniques has been tentatively established by comparative analysis of a small set of coprolite pollen data. Now it is important to ask what factors affect concentration values. We should consider the influences of coprolite substrate and intestinal passage, for example, on pollen concentration values. A recent analysis of mummified intestinal contents is informative in this regard.

## POLLEN CONCENTRATION AND MUMMIES

Dean notes that pollen concentration and relative frequency in modern feces are variable among individuals, and vary within one individual from day to day (Kelso 1976; Williams-Dean 1978). Modern studies of coprolites show that pollen is passed up to 32 days after consumption. Pollen is passed most abundantly two to four days after consumption, then in ever-decreasing amounts thereafter.

These studies have been critical in establishing the rate and amount of pollen passage through the digestive tract. My comments are not meant to diminish the contributions of Dean and Kelso. I am, however, concerned with directly applying these data to prehistoric peoples who had a very different diet with respect to fiber consumption, and eating habits that at times probably saturated the intestinal tract with pollen from a few species. Hunter-gatherer coprolites I have examined from Arizona, Utah, and Texas show that the majority of diet comes from a few plant taxa (Reinhard 1992). This probably relates to binge eating of seasonally abundant foods, a phenomenon also reported for modern hunter-gatherers (Cohen 1989). With respect to pollen consumption, it is possible that binging on a polleniferous food may alter the pattern described from modern fecal studies. One might expect the intestinal tract to become saturated with specific pollen types that are passed for many days in large quantities. Prehistoric diets are also high in fiber content. High fiber content accelerates passage through the intestinal tract and therefore may result in defecation of pollen over shorter periods of time but in higher concentrations per unit measure of feces.

Sobolik (1988) provides an example of the error in applying modern studies directly to coprolites. She attempted to ascertain the interval of time lapsed between pollen consumption and defecation based on pollen concentration values. The basic flaw with this study is the unquestioning application of modern studies to a prehistoric, high fiber diet which exhibits considerable evidence of binging. Sobolik presented minimal consideration of these aspects of prehistoric diet. She

also neglected Kelso's (1976) caveats regarding interpreting pollen concentration based on his analysis of modern feces.

Turpin et al. (1986) demonstrated that pollen was recoverable from intestinal contents of mummies. To gain an understanding of pollen passage through prehistoric people, I have initiated study of pollen concentrations in mummified individuals, beginning with mummified or partly mummified individuals from the Southwestern United States, and continuing in Peru. My goal is the recovery of mummified intestinal contents from different parts of the large intestine.

Unfortunately, finding mummies with full intestines is rare; only about 30% of mummies contain mummified intestinal remains and of these, fewer still have feces in various parts of the colon. Since I have not finished the analysis of all Peruvian mummies, my sample size is limited to five individuals. These are nonetheless instructive with respect to variability of pollen concentrations in mummified individuals and therefore relate to interpreting pollen concentrations of coprolites from latrine contexts.

As a study area, the large intestine has several advantages over the stomach or small intestine. First, multiple meals can be recovered from the large intestine. Secondly, the amorphous, more fluid nature of chyme in the stomach and small intestine forms into defined, harder feces after a few hours in the large intestine. Thirdly, the large intestine has well defined areas that are easily identifiable in mummified individuals: the ascending, transverse, descending, and sigmoid portions of the colon. Coprolites can also occasionally be recovered from the rectum. Fourthly, although water content of the feces in the colon is inconsistent (there is greater water absorption on the cecum and ascending colon), it is more consistent than in the small intestine where water absorption is greatest. In the case of analyzing samples, the process of natural mummification results in consistent dehydration of the feces. Pollen concentration of chyme and feces may be affected by water content in living individuals, but this is probably not a factor in dead, desiccated individuals. Thus, in the large intestine, distinct masses of concentrated, dehydrated fecal material can be recovered in anatomical association (reflecting the location and shape of distinct haustra) that are relatively consistent in water content. The study of these remains allows one to evaluate the passage of pollen through the intestine as reflected by pollen concentration values.

Occasionally, partially mummified individuals are excavated, but anatomical association of the large intestine contents are not noted. Two such cases are discussed below. In one of these, it was possible to fit the separate coprolites together to reconstruct their approximate association. However, it was not possible to determine which end of the series was higher in the intestinal tract. It was still possible to sample different regions of the colon.

One of the major factors that affects pollen concentration in feces is the nature of food eaten. Foods vary widely in pollen content and component digestibility. Obviously foods with high pollen content will produce coprolites with pollen. However, prehistoric peoples typically had diets high in nonsoluble carbohydrate (fiber) in the form of vascular bundles, seed testa, epidermis, and other plant structures. Thus, the amount of fiber in the diet will affect the concentration of pollen in feces. The only incorrect assertion in Dean's review is that "many post-Archaic coprolites were fiber free." I have analyzed 373 coprolites from post-

Archaic Southwestern sites (Reinhard 1992) and consistently find fiber to be the dominant component of coprolites. The nature of fiber differs between Archaic and post-Archaic coprolites with vascular tissue being more common in Archaic coprolites and seed testa more common in post-Archaic. Perhaps this is the difference Dean is referring to, not to the general fiber content of coprolites.

Reinhard and Hevly (1991) present the results of a study that illustrates the effects of different pollen and fiber concentrations on mummified feces. Four coprolites were recovered from a partially mummified individual. Two were black and granular and two were light brown and fibrous. One of each type was analyzed. We determined that the dark coprolites came from adjacent haustra and the light coprolites from adjacent haustra, but it was impossible to determine which pair of coprolites was higher in the digestive tract.

Examination of remains from one dark, granular coprolite revealed ground saguaro cactus seed *(Carnegiea gigantea)* and fibers of mesquite pods (*Prosopis* sp.). To quantify the remains, the hila of the ground seeds were counted. A minimal count of 439 saguaro seeds per gram of coprolite was obtained. In addition 11 insect fragments, 13 mesquite pod fragments, 1 grass leaf, and 5 unidentified seeds were observed. In contrast the macroscopic remains of a fibrous coprolite were dominated by mesquite pod fragments. Two peduncles of mesquite pods were found among 46 mesquite pod fragments. We also identified 105 saguaro seeds, mesquite leaf, and a human hair.

Palynological examination revealed a preponderance of cactus pollen in both granular and fibrous coprolites. The pollen concentration value of the granular coprolite was 500,000 grains/gm. Of these, 487,500 were consistent in morphology with saguaro pollen, 11,000 with *Opuntia* sp., and 1,500 were from nondietary, wind pollinated plants. From the fibrous coprolite, only 60,000 pollen grains per gram were recovered, 35,000 of a type similar to saguaro, 6,000 from *Opuntia,* and the remaining from nondietary, wind pollinated plants.

I believe that the dark, granular coprolites are the residue of saguaro seed "cake" and the fibrous coprolite represents a meal of whole mesquite pods. The *Opuntia* sp. pollen is the residue of yet another meal, or the result of indiscriminate pollination of *Opuntia* cactus to saguaro. I believe that the saguaro pollen was probably ingested with the seeds since saguaro flowers are not dehiscent and therefore contamination of seeds with pollen while extracting the seeds and eating mature fruit is a strong possibility.

This mummy, with two meals represented, reflects the effects of dietary pollen and fiber content on pollen concentrations. The mesquite meal was low in pollen and high in insoluble fiber. Although the saguaro seed meal had a high fiber content in the form of seed testa, it was also high in pollen. In this case, the remarkable reduction in pollen concentrations of the mesquite meal (487,500 to 35,000 saguaro-like pollen) is due at least in part to the introduction of large amounts of fiber. The saguaro seed content of the fibrous coprolite was about 1/4 that of the dark, granular coprolite, but the saguaro pollen content was reduced to about 1/14. This shows that fiber content of a meal has a pronounced impact on the pollen concentration of the coprolite resulting from that meal.

Examination of coprolites from the Dan Canyon burial (Dominguez et al. 1992) provided an instructive case to evaluate whether pollen concentration in

feces from a single individual varied independently of fiber content. Twenty coprolites were recovered from the excavation of this partially mummified individual. After reconstructing the anatomical order of these coprolites, I sampled three different regions of the colon, probably the ascending, transverse, and descending regions. Three coprolites (A, B, and C) were selected from these areas and processed. Macroscopically, all twenty coprolites were composed exclusively of finely ground grass testa. Thus, in this individual there was consistent dietary residue, and therefore consistent fiber content, between the portions of the colon. This makes it probable that the individual ate several meals of ground grass. Indeed, analysis of foods buried with the individual showed a preponderance of *Oryzopsis* sp. (Indian rice grass). Archaeological reconstruction of the burial also suggests that the individual was buried at a time of low food diversity, probably limited largely to uncultivated grasses. Pollen concentrations derived from this burial should provide an idea of the impact of "binge" eating of a single food source.

It is noteworthy that pollen concentrations varied among coprolites. For sample A, 23,800 grains/gm were recovered, for B 49,500, and for C 19,900. The vast majority of pollen was derived from uncultivated grass (Poaceae). *Ephedra* (Mormon tea) pollen was also present as were trace amounts of *Pinus* (pine) and *Artemisia* (sage brush). Pollen aggregates were noted for Poaceae and *Ephedra*. The variation of pollen concentration was due to variation in grass pollen content. I think it very likely that grass pollen was ingested with the ground grass seed. The occurrence of torn grass grains is consistent with this interpretation: they resemble torn maize grains described by Bryant and Morris (1986) resulting from mechanical breakage on grinding stones.

Despite the fact that food residue was consistent, the pollen concentrations varied. This indicates that consistent diet over a period of time does not result in even distribution of pollen in the intestinal tract. The varying pollen concentrations in otherwise consistent matrices indicate that there is variation due to the influence of undefined factors on pollen concentrations.

Extreme variation in pollen concentration values within a short distance in the intestinal tract is illustrated by the study of mummy T-10, S-241 from the site of Chiribaya Alta, Osmore Drainage, southern Peru. Five samples were recovered: ascending colon, transverse colon, splenic flexure, upper end of the descending colon, and middle of the descending colon (Fig. 3). Five "meals" are present in the colon. In the ascending colon, the coprolite macroscopic residue contains crustacean fragments and manioc tissue in a fine brown matrix composed of ground seed testa. The coprolite in the transverse colon contained possible starch aggregates in a light brown matrix. The splenic flexure contained ground fish bone in a matrix of amorphus, light brown material. The upper descending colon contained crustacean remains and manioc tissue in a dark brown matrix identical to that found in the ascending colon. In the middle of the descending colon, starch aggregates, maize hulls, and crustacean fragments are present. The sequence of foods was consumed in reverse order of that summarized above.

Pollen spectra from the coprolites were dominated exclusively by Cheno/Am grains. Pollen concentrations of Cheno/Am varied between regions of the colon: 9,000 in the ascending colon, none in the transverse, none in the splenic flexure,

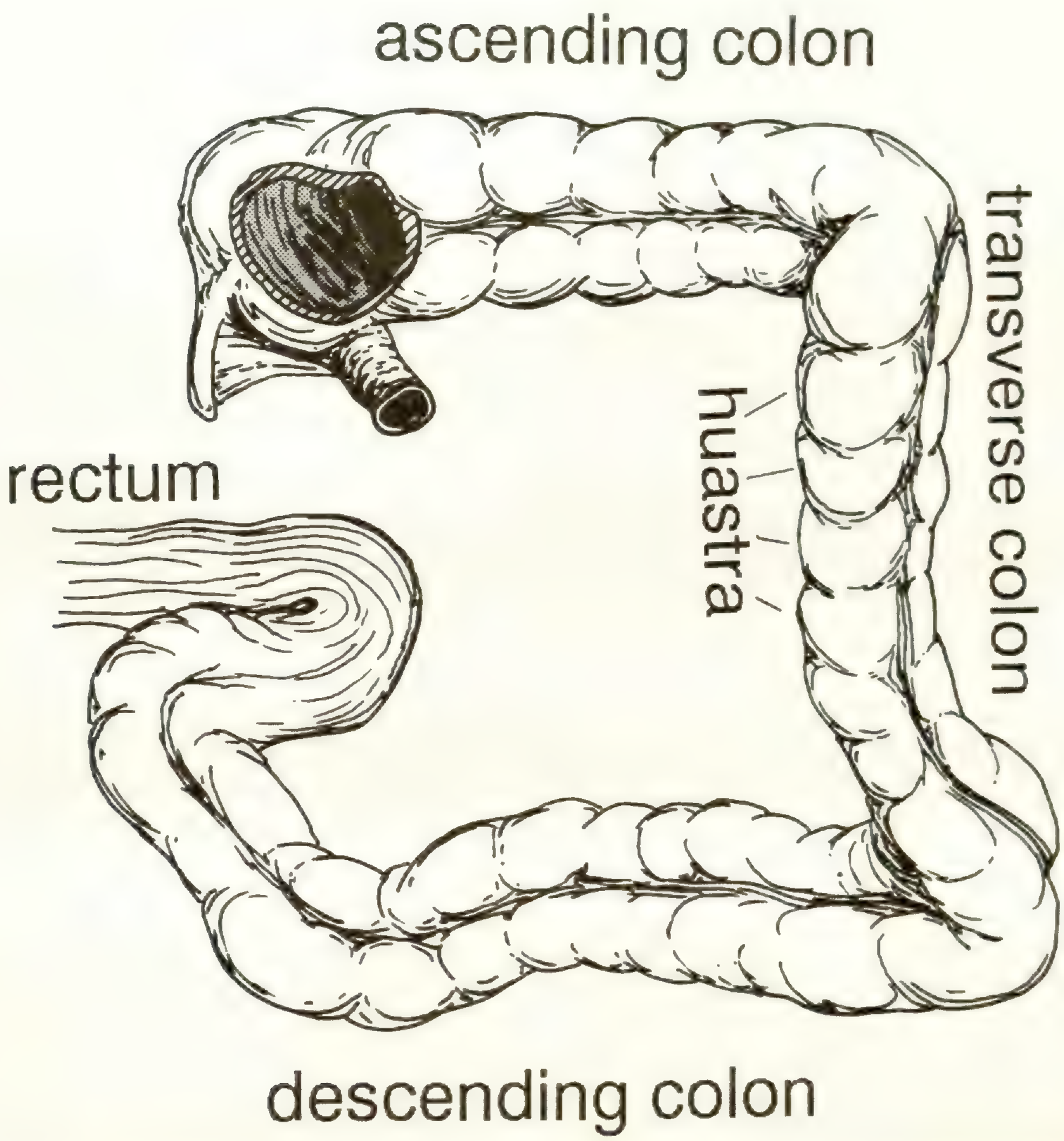


FIG. 3.—Diagram of the large intestine showing anatomical regions sampled for coprolites.

8,200 in the upper end of the descending colon, and 3,400 in the middle descending colon. Higher pollen concentrations are associated with the brown matrix derived from finely ground seeds. The lower concentration in the middle descending colon is probably due to partial mixture of meals between the two descending colon samples. The range in pollen concentration from total absence to several thousand grains per gram which existed in coprolites located a few centimeters apart is not what one would expect based on studies of pollen in modern feces. Gradual voidance of pollen over several days after consumption is indicated by those studies (Kelso 1976; Williams-Dean 1978). The residue from this mummy's large intestine indicates that pollen tended to maintain intestinal position in association with source macroscopic material rather than become dispersed clinally throughout the length of the intestine. Perhaps high bulk diet caused this.

Two other Peruvian mummies from which multiple samples were recovered

contained no pollen at all. One mummy, T-325, S-3763 from Chiribaya Alta, contained coprolites in the sigmoid and descending colon. The sigmoid colon contained maize vascular tissue, other monocot vascular tissue, boiled maize hulls, and spongy fiber vascular tissue. The descending colon contained *guava* seed testa, *molle* leaf tissue, and monocot leaf tissue. The other mummy was recovered from Algonodal, a site near Chiribaya Alta. Coprolites were recovered from the caecum, the ascending, transverse, and descending colon, and rectum. The only identifiable material in the caecum was monocot leaf tissue. All other coprolites from this mummy contained boiled maize hull, woody tissue, and maize leaf tissue. It is unusual for maize hulls to be found without maize pollen in coprolites in the Southwestern United States. The fact that five coprolites from two Peruvian individuals contained macroscopic maize but no pollen suggests that differences in maize preparation techniques between the two regions may have had an impact on the pollen content of consumed maize. Thus, the evidence indicates that food preparation technique, in addition to intestinal action, affects pollen abundance as reflected in pollen concentration values.

Analysis of mummy intestinal samples highlights issues relevant to the interpretation of pollen concentration values from coprolites. Admittedly, the sample of mummies presented above is small. We need to build on this data base, and some of my current research is focused on this problem. Therefore, I present the following observations without generalizing them to pollen concentrations in coprolites. First, there is an interaction between the amount of insoluble fiber and pollen content of foods that affects concentration values. Secondly, even in consistent coprolite matrices from the same individual, pollen is not distributed equally. Therefore, some variation can not be explained on the basis of food texture alone. Thirdly, in the case of one mummy, different foods resulted in differing concentration values in coprolites located very close to each other in the intestinal tract. Contrary to modern studies of fecal pollen content, this indicates that pollen can pass through the intestine in distinct concentrations that do not readily mix between food residues. The most important lesson to be learned from the study of mummies with respect to pollen data is that one must be aware of the macroscopic content of coprolites in order to interpret pollen concentration values.

## POLLEN AGGREGATES

Dean raises the issue that pollen aggregates potentially reflect human behavior, and that processing technique affects the integrity of pollen aggregates. Both of these issues need to be addressed.

Since Bohrer (1981) established the importance of pollen aggregates in archaeological analysis based in part on her dissertation research (1968), archaeological palynologists have interpreted the presence of pollen aggregates of some species as evidence of human utilization. Although I have previously used pollen aggregates as evidence of fecal origin (Reinhard et al. 1992), after considering aggregate data from a number of coprolites, I now believe that pollen aggregates are much more common from nonfecal contexts than from coprolites. Furthermore, processing technique does not seem to impact the few pollen aggregates that are present in coprolites.

During the past ten years I have used very different processing techniques on coprolites. From 1981–1984, for example, I was interested in examining parasite eggs, fungal spores, and pollen grains in the same preparation. This necessitated moderating the chemical treatments typically used in palynological processing. My coprolite processing involved rehydration, disaggregation, screening, light acetolysis (3–5 minutes), and brief treatment (30 seconds) in 5% potassium hydroxide. Between 1984 and 1989 my emphasis was on obtaining very clean pollen preparations. Processing involved rehydration, disaggregation, screening, hydrochloric acid, hydrofluoric acid, zinc bromide heavy density separation, sonication, long acetolysis (20 minutes), and potassium hydroxide treatments. Since 1989, I have moderated my processing technique to rehydration, disaggregation, screening, heavy density separation, and moderate acetolysis (5–10 minutes).

Through these years of coprolite study, I have noted the presence of pollen aggregates (pollen clumps of three grains or more). I have not noticed a decrease in the yield of pollen aggregates despite applying different processing protocols. To verify this, I recounted coprolite preparations from two different Anasazi sites, Turkey Pen Cave, Utah, and Salmon Ruin, New Mexico, giving special attention to pollen aggregates. I selected these sites because both are sites with similar diets and pollen representation. Turkey Pen Cave coprolites were processed in 1983; Salmon Ruin coprolites in 1988. These two sites represent the extreme ends of my processing spectrum: Turkey Pen Cave was processed with minimal chemical treatment and no sonication, Salmon Ruin with the most extensive series of treatments.

Of the 10 Turkey Pen Cave coprolites, only five are countable today. The following observations can be made. Sample 263 was dominated by *Cleome.* Two hundred *Cleome* grains were counted of which only one was an aggregate of three grains. Sample 164 was especially rich and over 4,000 grains were counted in three microscope preparations. Of these 3,066 were *Cleome.* Only two aggregates were found, both of *Cleome,* one consisting of four grains, and one consisting of a large aggregate of over 100 grains. Sample 238 was dominated by *Cleome;* 252 grains were counted including two aggregates of three grains and about 50 grains. A *Zea mays* aggregate of five grains was also found. Sample 163 was dominated by high spine composite pollen of which 111 were counted. There were no aggregates. Sample 236 was dominated by Poaceae pollen; 194 were counted, including one aggregate of four grains. Thus, the samples processed with minimal chemical baths and no sonication produced a very sparse representation of pollen aggregates.

The Salmon Ruin counts from 10 coprolites also show low frequencies of aggregates. Twenty-two *Cleome* aggregates larger than three grains were found in five samples. Between 200 and 1,000 grains were counted for each sample. I believe that *Cleome* counts are especially relevant to the question of the importance of pollen aggregates. *Cleome* is an insect pollinated genus and Native Americans used the flowers/buds as seasoning. It should produce pollen aggregates in large numbers. Four Cheno/Am aggregates were also found in two samples. These data indicate that aggregates are recoverable from highly processed and sonicated samples. However, it is clear that pollen aggregates are not abundant, and that more extensive preparation technique does not reduce the number of aggregates. I agree

with Dean that further evaluation of this issue should be made by comparative processing and counting from the same coprolites.

These data illustrate that pollen aggregates are not common in coprolites; pollen goes through mechanical and chemical disaggregation between the time it is obtained from plants and the time it is defecated. Winnowing, grinding, and cooking may impact the presence of pollen aggregates. Food mastication is the beginning of the mechanical disaggregation process that continues through the intestine in the form of peristaltic pressure. Exposure of food to acidic pH in the stomach followed by digestive enzymes in the small intestine are chemical processes that result in further disaggregation. Thus, although pollen exine passes through the intestine intact, aggregates of pollen are broken. Therefore, it is seems that pollen concentration data or even relative frequencies are much more significant than pollen aggregate data in interpreting human use of food plants through coprolite analysis. It is a mistake to emphasize pollen aggregate data.

## CONCLUSION

After preliminary evaluation of statistical variation of pollen concentration values and relative frequency values, I agree with Dean that there is different information conveyed by the two expressions of pollen counts. I tentatively agree that pollen concentration values may provide more definitive evidence of plant consumption that relative values. This requires further, intensive statistical evaluation.

Although I recognize Dean's (Williams-Dean 1978) and Kelso's (1976) studies of modern passage of pollen through the intestine as especially insightful work, I believe that considerations of fiber content and binge eating must be incorporated into any model regarding the analysis of prehistoric pollen concentration data. Analysis of mummies demonstrates that these considerations are important in evaluating how pollen passes through the intestine and becomes distributed in coprolites.

I disagree that pollen aggregate data are as significant as pollen concentration data in interpreting prehistoric plant use. I believe that the preingestion processing of plant foods, postingestion mastication and peristaltic pressure, and exposure to digestive acid and enzymes breaks pollen aggregates while maintaining high pollen concentration values.

With regard to differences in ethnographic interpretation of pollen data as reflecting medicinal use of plants, I recognize that Dean presents alternative explanations, but feel most confident in the original assertions presented by Reinhard et al. (1991). This is a case of different researchers coming to different conclusions from evaluation of the same data.

Clearly, the value of pollen concentration data in coprolite analysis requires additional statistical evaluation. The data set I have collected over the past years is large enough for statistical study and this is underway. Since Dean clearly has insights into coprolite pollen data that are different than mine, I have invited her to evaluate these data with me. I anticipate that we will carry out a thorough analysis together. Thus, the productive research into pollen concentration applied to coprolites will continue beyond this exchange of ideas.

## ACKNOWLEDGEMENTS

I thank John Dendy, who participated in the analysis of Peruvian mummy contents.

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## OPINIONS

In the last issue of the *Journal of Ethnobiology,* it was announced that an editorial space would be opened in the News and Comments section. Readers are invited to submit articles of less than 500 words that comment on the applied aspects of ethnobiological research or other issues of concern to ethnobiologists. Opinion pieces are selected and edited by the News and Comments editor but are not sent for outside review. The opinions expressed are those of the author(s) and do not necessarily reflect the policy of the Society of Ethnobiology, the *Journal of Ethnobiology,* or its editors.

### THE FUTURE FOR INDIGENOUS SEA TENURE MANAGEMENT OF LIVING MARINE RESOURCES IN PAPUA NEW GUINEA

by David Hyndman, *Department of Anthropology and Sociology, The University of Queensland, Brisbane Qld 4072 Australia*

Although the ethnographic record demonstrates that Melanesian customary marine tenure (CMT) systems in Papua New Guinea (PNG) and the transboundary Torres Strait Islands are diverse, flexible, and dynamic and capable of regulating many kinds of subsistence and commercial activities associated with marine fishing, hunting, and gathering (see Hyndman 1993), Haines (1982:289) has bluntly stated that it is "counter-productive to resurrect the past by entrenching traditional fishing patterns, or rather the modern distortions of them in the PNG ad-

ministration." Polunin (1990) and Johannes and MacFarlane (1992) have likewise found little in CMT that offers the potential to mitigate the effects of massive change. The legal and political fate of CMT practices vital to over 400,000 ethnically diverse coastal peoples of PNG has become a contentious issue, which raises the critical ethical issues of CMT research as to what extent, if at all, do outsiders (anthropologists included) have the right to speak about and represent indigenous peoples' sea tenure systems. The highest standards of professional accountability must apply and CMT studies should proceed only with the consent and active collaboration of indigenous peoples involved. The people themselves should have the final say about what constitutes their CMT system.

In analysing the potential and desirability of integrating CMT in contemporary fisheries and marine management frameworks, Cordell (1992:122) suggests that the following three questions stand out: (1) what happens to CMT patterns during the transition from subsistence to commercial economies, (2) what are the resource management and biological conservation impacts of CMT, and (3) what uses, if any, can be made of CMT systems which work to define user and access rights—in essence to preserve the social order—rather than the balance of nature.

On the first question Wright (1990) has already described CMT systems in PNG that have successfully negotiated the transition to modernity through commercial fishing ventures and has suggested that directions for utilising CMT in the development of marine resources in PNG may be found in the judicial system used at present to resolve village disputes over land rights. On the second question Clarke (1990) has summarized how closed areas and seasons, food taboos, and game restrictions have enhanced species conservation. Indeed, CMTs in Melanesia are some of the most extensive and sophisticated traditional knowledge systems in Oceania for spatially managing and socially regulating coral reef fisheries. These are not broken down traditions but living customs, which have always transformed and related to basic resource management tasks. On the last question, what these CMT systems really do is consolidate a peoples' control over fishing grounds and defend against encroachment. Management utility of CMT systems should not stand or fall merely on the basis of a conservation test.

Indigenous peoples' choices in aquatic resource use in PNG and the transboundary Torres Strait Islands cannot be explained by common property models. The terminology itself is misleading and inappropriate (Nietschmann 1989). Common property assumes a model of optimisation, that people act out of self-interest alone without regard for community. Lack of community designates the commons but under CMT, sea tenure holders in PNG are well-defined peoples who do not lack use rights. Sea tenure represents important attempts by indigenous peoples to deal with problems of managing resources by controlling and restricting access to entry.

More research will enable policy-makers to go beyond documenting general features of CMTs to specifying how they can be integrated with contemporary systems of marine use. In PNG one promising avenue for indigenous owners of CMT systems to become involved in the protection of their living land and marine resources is through wildlife management areas. Maza is currently the only completely marine management area and covers 184,230 ha in the transboundary Torres Strait Island region. Government policies and CMT systems need to ac-

commodate to one another. What seems imperative is the principle and obligation of the PNG government to uphold indigenous peoples' rights and controls over their ancestral marine domain. It is impossible to isolate the sea from the total fabric of maritime economy and culture. It is through customary sea tenure that PNG maritime peoples are progressing with the past and forging their cultural identity in the modern world.

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# BOOK REVIEWS

***Nch'i-Wana*, "The Big River": Mid-Columbia Indians and their Land.** Eugene Hunn with James Selam and Family. Seattle: University of Washington Press, 1990. Pp. 390. ISBN: 0–295–96851–6. $30.00 (cloth).

> We immigrants, who call ourselves "natives" after one paltry generation on the land, can scarcely fathom what it means to the Indian to walk on a land in which a hundred generations of ancestors have been buried.

So writes Eugene Hunn, his words reflecting the same spirit of humility and respect that has long guided traditional Native American peoples in their relationships to the natural world. In this study, Hunn and his Plateau Indian collaborators richly detail the interchange between a human community and its environment. The people are contemporary Sahaptin speakers, living in or near the Yakima, Umatilla, and Warm Springs reservations of Washington and Oregon. What emerges in this book is a body of ancient knowledge and a portrayal of the lifeway this knowledge has long sustained, a lifeway quietly persisting within earshot of highway America.

For ethnobiologists, *Nch'i-Wana* is a lavish feast of information, carefully researched and skillfully presented. Chapter topics include: regional history from first contact through 1987; language and linguistics; subsistence ecology and seasonal round; knowledge and uses of animal and plant resources; ecological perspectives on social organization; traditional and modern religion; and contemporary land-related political issues. Along with the descriptive material are theoretical discussions of interest to ecological anthropologists on topics such as sexual division of labor and the relationships between environment and political organization. Attentive to his lay readers, Hunn also provides clearly written background information, along with lively explanations of anthropological approaches and principles.

The book is very well produced, with fine graphics and plentiful illustrations. The appendices are a study in themselves, including a list of over four hundred categories of animals and plants named by Sahaptin speakers. For each of these taxa, states Hunn in the book's Introduction, "one could write a long, fascinating, and intricate story." The main text provides abundant evidence for the truth of this statement and excites interest in Hunn's promise of more writings to come.

Underlying this work is a collaboration that spanned thirteen years at publication and continues as a "life-long, if part-time occupation" for Eugene Hunn and his instructor James Selam. The partnership includes Selam's critical readings of the manuscript, and Hunn's struggles to meet his responsibilities to a diverse audience that includes both the Native American and academic communities, as well as naturalists, students, and general readers interested in the topic or region.

Anyone experienced with ethnographic research will recognize the commitment to high standards in every aspect of this study. Of particular importance is

Hunn's ethically-founded relationship to his Native consultants and their community, his long term dedication to recording their traditions, and his efforts to assure accuracy in every written detail.

As a passionate devotee of descriptive ethnography, I found three chapters especially fascinating: the overview of subsistence ecology, the marvelously detailed compendium of plant and animal resources, and the discussion of Plateau Indian religious beliefs. Together, these chapters comprise an alternate guidebook to mid-Columbia River natural history.

The book contains hundreds of delightful tidbits like this one: Raven's voices often bring portentous messages, but crows, "though talkative, rarely say anything of significance." There are items to delight the folk taxonomist: For example, Sahaptin speakers distinguish two varieties of *Lomatium canbyi* not so much by their extremely subtle visual characteristics as by their differences in taste, one being used for savory root cakes and the other fit only to be eaten by "ground hogs." And there are insights like the following about Plateau subsistence ecology: In this environment, fiber plants were as important as food plants, because survival depended upon the ability to carry preserved edibles over long distances.

Eugene Hunn deserves a special accolade for the attention he has given to writing; his descriptions of mid-Columbia life are polished, fluid, and evocative. Woven through the text are stories, some told by his collaborators or gleaned from the literature, some drawn from the ethnographer's own experience. This makes the work engaging and readable, while also giving it an organic quality not present when the information is wholly dissected and restructured. Hunn takes his readers in pickup trucks to subsistence sites along remote country roads, up dry hillsides to gather plants and listen to the women tell stories, into cool streambeds to catch shiners on hooks baited with caddisfly larva. These recountings breathe life into the landscape, the people, and the culture that has evolved through their conjunction.

Taken as a whole, the book creates a sense for the Plateau Indians' active, participating membership in a community of natural beings, all of them imbued with spiritual power and accorded the status of persons. "The plants and animals, birds, fish, and insects are all named, familiar partners in the enterprise of survival." The moral imperatives that exist among members of human society are extended to the entire ecosystem. Hunn emphasizes his respect for this worldview: "I see in animism . . . a strange but powerfully consistent moral vision that makes us take our place beside those other living creatures whose futures are joined with ours. Such a moral vision seems altogether appropriate for a hunting-gathering people and embodies a wisdom we should seriously consider."

If I understand correctly, Hunn is suggesting the ethical and religious system that binds Plateau Indians to their natural surroundings may be more than simply interesting. The long-tested principles underlying this system could also be *important,* as we seek means to rectify the imbalances between industrial cultures and the world environment. With people from a wide range of disciplines plumbing the anthropological literature for insights on human-environmental relationships, ethnobiology is taking on a significance pioneer researchers might never have imagined. There is perhaps less need to invent a "new" environmental ethic than to rediscover an old one.

Recognizing the universality of human wisdom is among the first principles of anthropology and is surely the discipline's greatest promise. Eugene Hunn writes: "I can see myself reflected in the faces of these Indian people. . . . The mid-Columbia Indians are our long-lost brothers and sisters. Too bad that we for too long mistook them for strangers." But we still have the chance to correct our error, as this book demonstrates. Among its major achievements is the deep sense of empathy and shared purpose—the fundamental convergence of humanness—between the anthropologist Eugene Hunn and the Plateau Indian elders who have taken him into this apprenticeship.

In ethnobiology, the doors are opening on yet another promise. Studies of traditional peoples bring us in touch with an ancient and profound wisdom, that humans and nature are not separate but comprise one vast, encompassing community. This view, which appears to have guided Native American peoples during the long passage of millennia, is meticulously explored in *Nch'i-Wana*. Congratulations to Eugene Hunn, James Selam, and the other Plateau Indian people who made the book possible.

Richard Nelson
Affiliate Professor of Anthropology
University of Alaska
Fairbanks, Alaska 99701

**Wilson Popenoe: Agricultural Explorer, Educator and Friend of Latin America.** Frederic Rosengarten, Jr. Lawai, Kauai, Hawaii: National Tropical Botanical Garden, 1992. Pp. viii, 182. $22.95. ISBN 0–935–86853–4.

Frederic Rosengarten, a widely known author, has given us a very personal and complete story of the life and work of one of the great masters of agricultural exploration of this century: Wilson Popenoe. The authenticity of this extraordinarily detailed disquisition is assured, since Rosengarten was a personal friend for many years of Wilson Popenoe, and Rosengarten himself spent most of his life in plantation work and management in Central America with plants introduced from abroad; furthermore, he is an accomplished author of several successful botanical books including *The Book of Spices* and *The Book of Edible Nuts*.

Wilson Popenoe was endeared to the tropics from his early years of residence in Costa Rica. During his youth, he divided his time between school and working in gardening and horticulture: he said that he spent more time propagating plants than burning the midnight oil studying. As to be expected, he excelled in the natural sciences but did not do well in other subjects. The rest of Popenoe's outstanding and really pioneering life was eventually with the United States Department of Agriculture. While his travels and studies on the introduction of new economic crop plants or local variants of those already established took him to many parts of the world, particularly Indonesia, his "first love" and major interest was with Latin America.

This book is a meritorious treasure, providing not only an account of the life-long dedication of Wilson Popenoe but also an historical resumé of much of the

work accomplished by him in the study and introduction to cultivation of many tropical plants and their variants. Today, how many of us appreciate the results of his work, when we purchase and daily eat so many exotic plants and plant products?

The book will command a broad audience—not only of economic botanists, agronomists and ethnobotanists but of scholars in many aspects of Latin American history, development and commerce as well as conservationists, particularly to specialists in biological diversity.

Rosengarten has divided the book into 13 sections: 1) Early years, 2) Brazil: the Navel Orange; 3) Florida and Cuba: the Mango; 4) Guatemala: the Avocado; 5) Mexico and Washington: *Manual of Tropical and Sub-tropical Fruits;* 6) Costa Rica and Colombia; 7) Ecuador, Peru and Chile; 8) Washington: Marriage to Dorothy Hughes; 9) Lancetilla, Honduras: United Fruit Company; 10) Antigua, Guatemala: Casa Popenoe; Guatemala: Cinchona; Zamorano, Honduras: Escuela Agricola Panamericana; 13) Retirement years.

There follows a list of Popenoe's principal publications (1911–1917), a bibliography of references and an index.

The time for an elogium of Wilson Popenoe is long overdue, for he died in 1975. His nearly life-long friend, Frederic Rosengarten, has fortunately filled in this lack in our bibliography of economic botany.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

**Contribuciones Latinoamericanas al Mundo. La Utilización de las Plantas en Diversas Sociedades.** Miguel Angel Martínez. Red Editorial Iberoamericana, Lago Mayor 186, Col. Anahuac, Delegación Miguel Hidalgo, Codigo Postal 11320, México, D.F., México, 1990 (second edition). price not given. ISBN 84–207–3068–8.

This little book, written in Spanish, begins by emphasizing the cultural and economic importance of plants, mainly those outside of their native homes and ends with considerations of possible future contributions from the Iberoamerican flora.

The book is divided into six sections: 1) Economic and cultural part of plants in human societies; 2) Food plants; 3) Medicinal plants; 4) Industrial and ornamental plants; 5) Present and future contributions of the flora; 6) Interesting information. A total of 116 species are considered, often with extremely interesting local uses not widely known.

A publication written in a popular style, it will undoubtedly play a role in wide circles often oblivious to modern man's continued dependence on the Plant Kingdom.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

**The Subsidy from Nature: Palm Forests, Peasantry and Development on an Amazon Frontier.** A.B. Anderson, P.H. May and M.J. Balick. New York: Columbia University Press, 1991. Pp. xxv, 233. no price given. ISBN 0–231–07222–8.

The basic message of this outstanding book appears to be environmental conservation, even though its central theme revolves around the babassú palm and its potentialities for a region of the eastern Amazonia of Brazil which has already suffered from wanton forest destruction to an unbelievable extent.

As Malcolm Gillis states in this preface: "Evidence of the economic, social and ecological costs of tropical deforestation has grown steadily over the past decade, but so has the pace of this destruction. . . . It is not necessary to invoke the specter of global warming . . . to make a compelling case for arresting the present pace of tropical deforestation . . . . The authors . . . [propose] an unusually innovative and comprehensive examination of the possibilities for sustained management of tropical forest resources."

This approach goes beyond the high economic and ecological cost to the human race of destruction of environments. They combine the knowledge of their academic and field work in the natural and social sciences to the potentialities of exploitation of the wild stands of this useful palm in the babassú region of the southeastern Amazon of Brazil, especially in the State of Maranhão.

In addition to its highly practical suggestions concerning the value of the extraction of babassú oil in household and in market economy, the authors have considered in depth the natural history of this most promising natural resource.

The book is organized with 7 sections: 1) Nature's Subsidy (in which deforestation,—natural food and babassú as a subsidy from nature are discussed); 2) Regional Setting (of areas where the sundry species of *Orbignia* occur; 3) Natural History of Babassú; 4) Babassú in Household Economy; 5) Babassú in Market Economy; 6) Prospects for Development; 7) Nature's Subsidy Revisited. There follow a number of statistical appendices and explanatory notes on the contents of the six of the seven sections. The bibliographic references numbering 236 easily indicate the breadth and depth of the coverage of the book. A detailed index provides an easy key to the wide-ranging topics treated in the volume.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

**La Guia de Incafo de las Plantas Utiles y Venenosas de la Península Ibérica y Baleares *(Excluidas Medicinales).*** Diego Rivera Nuñez and Concepción Obon de Castro. Incafo, S.A., Castello 59, 28001, Madrid. Pp. 1257. price and ISBN not given. [order from: Mundi-Prensa Libros, S.A. (91) 575 39 98 (FAX for consulting), Madrid, Spain].

This handy-sized (4" x 8") book of 1257 pages and 386 excellent color illustrations is a model for geographically localised floras. Each entry has the common

name under the Latin binomial—always in Spanish and (when the plant grows in the non-Spanish speaking areas of Spain) in Catalán and Euskara. Vernacular names are often given in Portuguese, French, English and German as well. Interesting etymological analyses of the Latin names are frequently given. A description of the plant is followed by notes on the habitat, flowering period and uses (if any). There is an excellent bibliography of 21 pages followed by a page of clever symbols signifying uses, and this is supported by a very complete and detailed page index of the uses of plants, occupying 80 pages.

It is not usual to find such a local economic botanical book with so much information so easily available.

Richard Evans Schultes
Director Emeritus
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

**Narrenschwämme: Psychotrope Pilze in Europa. Herausforderung an Forschung und Wertsystem.** Jochen Gartz. Editions Heuwinkel, 22 rue de la Filature, CH-1227 Carouge/Geneva, Switzerland. 1993 Pp. 136 [3 Maps, 22 color plates (20 tipped-in), 39 black-and-white illustrations, 17 facsimile illustrations of extracts from mycological literature, 10 tables.] SFr.87.-/DM96.-(clothbound). ISBN 3–9063–24–7.

One of the most prolific phytochemical researchers on psilocybine-containing mushrooms, Jochen Gartz of Leipzig in the former Deutsche Demokratische Republik, has now published a valuable multi-disciplinary book on these fascinating organisms. The book is well bound and beautifully illustrated, except for the cover, which I find quite ugly, and not in keeping with the otherwise high graphic quality (although the paper chosen does not allow optimum reproduction of the black-and-white photographs). Nevertheless, this is a book every ethnobiologist interested in shamanic inebriants will wish to have. The title, *Narrenschwämme* (literally "fools' mushrooms"), is an old German name for psychoactive mushrooms, testifying to a traditional familiarity with these entheogenic mushrooms in the German-speaking world, and even today in Austria one might comment of the erratic and bizarre behavior of another: "Er hat verrückte Schwammerln gegessen"—"he has eaten crazy mushrooms." In a foreword, Christain Rätsch asks rhetorically: "who was the first fool?", in reference to the established antiquity of the human relationship with entheogenic mushrooms, which we now know to have been universal, its antiquity extremely remote.

After surveying his territory briefly, Gartz commences with a chapter on the "Liberty Cap" or *Psilocybe semilanceata* (Fr.) Kumm., which he rightly characterizes as the "classic" psychotropic European species, since it has been found in Austria, Belgium, Czechoslovakia, Denmark, England, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Romania, Russia, Scotland, Spain, Sweden, Switzerland and Wales, apart from numerous countries in North Africa and Asia, and besides being common in the United States and Canada. Together

with a map of its European distribution and color and black-and-white photographs, Gartz presents the mycological history of this species (illuminated by facsimiles of early and modern citations of the mushroom in the scientific literature), and its history of accidental and intentional use. There follow extensive quotations from reports of human experiments with the mushroom, the results of Gartz's chemical analyses of various collections (summarized in useful tables), and observations regarding cultivation, also illustrated with photographs.

There are six chapters with similar detailed treatments of the following species: *Psilocybe cyanescens* Wakefield; *Panaeolus subbalteatus* (Berk. et Br.) Sacc. (here curiously spelled *subalteatus,* in contrast to the spelling common in the mycological and chemical literature, including in two of Gartz's facsimiles); *Inocybe aeruginascens* Babos; *Gymnopilus purpuratus* (Cke. et Mass.) Sing.; *Conocybe cyanopus* (Atk.) Kühn.; and *Pluteus salicinus* (Pers. ex Fr.) Kumm. These species are presented more or less in the order of their importance, both ecological and ethnomycological, and there are good color plates of all except *C. cyanopus* which is rare (although there is a color plate of the cultivated sclerotium of this species). In every case, related species are also discussed and there are additional color plates of *Panaeolus cyanescens* (Berk. et Br.) Sacc., *Psilocybe baeocystis* Sing. et Sm, *Psilocybe bohemica* Sebek (which some European mycologists consider conspecific with *P. cyanescens,* as Gartz notes), *Psilocybe cubenis* (Earle) Sing. and *Psilocybe stuntzii* Guzmán et Ott. There is, however, no intent on the author's part to present a comprehensive listing of all known psilocybian species, a job which was adequately covered in a recent paper by Gartz, in collaboration with Mexican mycologist Gastón Guzmán and American ethonomycologist John Allen (Allen et al. 1992). Nonetheless, the species Gartz has chosen to profile in detail cover the most important genera of psilocybian mushrooms.

After a brief chapter warning of the dangers of confusing psilocybian mushrooms with amatoxin-containing *Galerina* species, and a note on the value and limitations of the bluing reaction some psilocybian mushrooms display as a key to their identification, there follows a chapter on cultivation of psilocybian mushrooms. This covers general principles of their cultivation but not step-by-step details (already treated in various publications), although there are 20 color and black-and-white photographs of mushroom cultures, showing seven different species. There are 11 photographs of cultures of the most widely-grown species, *Psilocybe cubensis,* whose cultivation became a cottage industry in the U.S. in the 1970s. Unfortunately, color plates 57 and 66 are switched; each tipped-in above the caption for the other. This is obvious to anyone who knows the mushrooms (*P. cubensis* and *P. semilanceata*) which are very distinct, but could confuse the beginner. Moreover, plate 39 *(Gymnopilus purpuratus)* is tipped-in upside-down, giving a curiously otherworldly character to the illustration. Hopefully the publishers will be able to remedy these deficiencies in future editions.

The remainder of the book deals mainly with ethnomycology, the modern use of these mushrooms by humankind. Although academic anthropologists have, by and large, ignored the contemporary ethnobotany of entheogenic mushrooms and other plants, I agree with Gartz that this phenomenon is every bit as important as their ethnobotany in traditional cultures. There are seven such chapters in all, each detailing a different geographical region. Starting with North America

and Hawaii, Gartz traces the spread of modern entheogenic mycophagy to Middle and South America, Australia, Europe, Japan, Africa, concluding with Asia and Oceania. The chapter on Africa discusses the now-famous rupestrian art of Tassili, which Samorini recently detailed, and which provides strong evidence for the existence of entheogenic mushroom use in Africa at least nine millennia ago (Samorini 1992).

The book concludes with two chapters on possible modern uses for the psilocybian mushrooms. Gartz proposes their use as aids in the diagnosis of brain damage, and discusses their proven value in psychotherapy. Gartz bemoans the legal restrictions which have slammed the door shut on this promising aid to psychotherapy, and expresses the hope that other countries will follow the lead of Switzerland (where psilocybine was first isolated by Albert Hofmann in the late 1950s and where Hofmann likewise first synthesized LSD 55 years ago), and reclassify these entheogenic drugs as experimental medicines, again allowing their use by psychotherapists. I share Gartz's confidence, that only by reopening the doors to thorough research of these and other entheogenic substances can we guarantee that the entheogenic mushrooms, what the Germans call the "fools' mushrooms," don't end up making fools of us all!

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Jonathan Ott
Natural Products Co.
Apartado Postal 274
Xalapa, Veracruz, México

**The Origins of Agriculture: An International Perspective.** C. Wesley Cowan and Patty Jo Watson. Washington and London: Smithsonian Institution Press, 1992. $49.95/£38.95/E$59.95 (clothbound); $19.95/£15.50/E$23.95 (paperbound). Pp. xvi, 224. ISBN 0–87474–990–5 (cloth); 0–87474–991–3 (paper).

This volume has eight regional sections, each by a noted scholar, plus introduction and concluding remarks by the editors. A thorough index, 32 figures, and 34 tables are included. Each chapter has its own list of references cited. The book seems directed to archaeologists and paleoethnobotanists, though it is all well-written and accessible to anyone with a serious interest in the origins of agriculture.

The editors' introduction gives some historical perspective on the search for the origins of agriculture and on paleoethnobotany. The editors are careful to lay a little groundwork for the nonspecialist by making clear some dimensions in the

study of early agriculture that specialists do not often reiterate. For example, a domesticate was not a sudden discovery made in prehistoric times, but the result of centuries or millennia of development.

The book offers detailed archaeological information but seldom lapses into minutia. Data are abundant and clearly presented in tables, charts, and maps. Most chapters consist largely of sections on natural environment, history of research, culture history, and plant species. In this way, the book is valuable for comparing and contrasting different parts of the world. Extensive references help those interested to pursue their special interests into the library.

Gary W. Crawford's chapter on East Asia emphasizes Japan but covers China and Korea, too. He describes over a dozen species of cultigens and discusses ancient evidence for their use. He also offers an explanation for the spread of plant husbandry in Japan.

Naomi F. Miller's coverage of the Near East makes an interesting case for interpreting different types of archaeobotanically mixed assemblages as fodder for domestic animals, as refuse from plant/crop processing or as evidence for the use of dung as fuel. She considers multiple types of evidence including technological, skeletal, ecological, botanical, and archaeological context.

Jack R. Harlan's chapter on Africa takes a different approach. He uses genetic, ecological, and geographic botanical evidence for the crop histories of sorghum, pearl millets, wild rice, and yams. By plotting continent-wide distributions of wild and cultivated species he shows where the several species were first domesticated and provides evidence for their diffusion.

Robin W. Dennell reviews recent models of European agricultural expansion and, with alternate explanations for the evidence, he makes a convincing argument that in some areas of Europe, agriculture was introduced and adopted quickly, but that in other areas, native species were gradually domesticated during a much longer period. The different relative speeds with which agriculture was adopted speak for the different ways that hunter-foragers and cultivators interacted with one another in different regions.

Bruce D. Smith's chapter on the woodlands of eastern North America is structured according to a six-part culture history extending from pre-5050 B.C. through post-A.D. 1150. Each of his sections is a concise yet detailed account of the plant/people relationship cast variously in terms of the interaction among climate, micro-ecology, botanical genetics, technology, and nutrition to explain the process of increasing human intervention in the life cycles of several plant species.

Paul E. Minnis argues that the demonstrably slow acquisition of agriculture from Mesoamerica by Archaic peoples in the Desert Borderlands of northern Mexico and southwestern United States did not drastically change ecological, economic, or social relationships. However, Archaic peoples appear to have been accomplished wild plant manipulators even without domestication.

Emily McClung de Tapia discusses Mesoamerica and Central America from the perspective of plant biological transformation and from the perspective of human manipulation of plant species. She favors Flannery's systems theory approach because, in part, the Mesoamerican context of domestication was different than those of the Old World.

South America is presented by Deborah M. Pearsall who emphasizes the wealth of evidence from the western coast and Andean highlands. She discusses the Lowland, Andean Mid-Elevation, and Andean High-Elevation agriculture complexes and presents the long culture history of plant domestication after 8000 B.C.

In summary, I recommend this valuable handbook to those interested in the current understanding of agricultural origins anywhere in the world. Regional specialists will benefit from having not only their own regions but many others, too, presented in comparable ways.

Mark W. Mehrer
Department of Anthropology
Northern Illinois University
DeKalb, IL 60115

**Beamers, Bobwhites, and Blue-points: Tributes to the Career of Paul W. Parmalee.** Edited by James R. Purdue, Walter E. Klippel, and Bonnie W. Styles. Springfield: Illinois State Museum Scientific Papers, Vol. XXIII, and Knoxville: University of Tennessee, Department of Anthropology Report of Investigations No. 52, 1991. Pp. ix, 436. $30.00 (hardcover); $19.50 (paperback). ISBN 0–89792–133–X (hardcover); 0–89792–134–8 (paperback).

This *festschrift,* consisting of 31 papers presented to Paul Parmalee, of the University of Tennessee, Knoxville, is a fitting tribute to one of the pioneers of North American zooarchaeology. The volume begins with a biography of Parmalee (McMillan) and a complete bibliography of Parmalee's writings (Morris and McMillan). Parmalee's own diverse interests are mirrored in the wide range of topics present in the remainder of this volume. Several of the papers deal with paleontology, osteology, and taxonomy, including studies of black bear (Graham), prairie vole (Martin), peccary (Robison), musk ox (McDonald et al.), redear sunfish (Colburn et al.), harelip sucker (Manzano and Dickinson), yak (Olsen), and reptiles and amphibians (Holman). Issues in estimation of body size are discussed for fish (Morey et al.) and deer (Purdue). Mussels and gastropods are well-represented (Bogan and Grady, Klippel and Turner, Mead, Theler, Warren), as are domestic dogs (Snyder, Wing).

Particularly welcome are several articles that deal with taphonomy, a subject that has often been ignored by Eastern Woodlands archaeologists. This concerns the pre- and post-burial processes that differentially modify or destroy bones. The presence of these articles in this volume is appropriate, given Parmalee's early recognition of the role of carnivores, birds of prey, and other taphonomic factors in patterning zooarchaeological assemblages. Lyman expands on his earlier research on the relation between utility indices and bone density by examining several previously published archaeological and ethnoarchaeological sites. He finds that skeletal part profiles from over 40% of the 67 assemblages are correlated with bone density, indicating the possibility that density-dependent destruction has patterned those assemblages. Furthermore, he argues that even if there is no correlation with bone density, a causal relation between element abundance and

transport decisions still must be demonstrated, rather than assumed. Skeletal part profiles are not enough, by themselves, to interpret prehistoric behavior. The taphonomic processes that affect skeletal element abundances must also be understood and controlled.

Munson reviews the use of white-tailed deer mortality profiles to infer hunting techniques. Introducing taphonomy into the discussion, he shows that the under-representation of fawns in many archaeological mortality profiles may be due not to prehistoric hunting techniques, but rather to destruction of the less robust immature mandibles by dogs. He derives a correction factor based on previously published survival rates of different-aged mandibles. When applied to a "natural" deer population profile, the resulting mortality profile is similar to many (but not all) archaeological assemblages, suggesting to him that deer hunting was rarely selective.

Munson's paper is a very significant one, and should be widely read. While (as Munson notes) Parmalee and John Guilday long ago recognized the possible biasing effect of taphonomic processing on mandibles, few studies of mortality profiles have adequately addressed them. Important as it is, Munson's study serves only as a cautionary tale, albeit a much-needed one, because he fails to address the fundamental question: how can archaeologists determine whether the absence of fawns is due to scavenging by canids, or to hunting techniques that did not select for fawns? Uncritical use of Munson's correction factor risks making the opposite error of assuming destruction. What is needed is a taphonomically informed analysis of faunal assemblages to determine the extent of carnivore (and other) modification. For example, the possibility that juvenile mandibles have been destroyed could be tested by examining surviving adult mandibles for evidence of carnivore gnawing.

Styles and Purdue attempt to distinguish differences in ritual and secular site use by comparing the fauna from three Middle Woodland sites in Illinois: a small village, a mortuary camp, and a burial mound group. The village assemblage has low, medium, and high utility deer elements, high taxonomic diversity, and low proportions of nonlocal species of worked bone. The mortuary camp assemblage is dominated by deer, particularly high-utility parts, while the burial mounds lack deer remains but have high proportions of nonlocal species, bone tools and ornaments. The differences in the skeletal part representation of deer at the village and mortuary camp are intriguing, especially in light of Lyman's article in this volume and other recent taphonomic research. Styles and Purdue, aware of the possibility that differential destruction may affect skeletal part profiles, show that relatively low density bones are present at both sites, which argues against differential destruction as a dominant factor. The meaning of different skeletal part profiles, however, is still widely debated, as the influence of economic anatomy, transport decisions, density, differential destruction, processing techniques, and analytical methods becomes better understood.

Grayson defends his earlier interpretation of small mammal remains from Gatecliff Shelter. Yet his statement that we cannot securely distinguish natural from cultural accumulations of small mammals in caves and rockshelters (pp. 107–108) ignores both recent research on small-mammal taphonomy and earlier, more qualitative observations of Parmalee and others. In fact, two other articles in this

volume develop ways to distinguish natural accumulations of small mammals from cultural accumulations. Semken and Falk use information on species diversity, relative abundances, and animal behavior to determine whether small mammal remains from archaeological pit features can be attributed to natural or cultural accumulations. Whyte conducted actualistic experiments to determine what animals are likely to become trapped in open refuse pits.

Three papers deal with faunal assemblages from historic sites. Rietz and Zierden conclude that patterns of cattle skeletal part profiles from sites in Charleston, South Carolina, may be more indicative of site function than of status. Martin emphasizes modified animal bones in his investigation of interaction and acculturation at French Colonial sites in the Midwest. Breitburg adds to the now-voluminous literature on the relative merits of MNI (= Minimum number of individuals) and NISP (= Number of identified specimens) to quantify relative abundances, and, based on several historic assemblages, comes out in defense of MNI.

Other papers emphasize paleoenvironment and paleoecology. Warren develops an elegant and flexible procedure for reconstructing aquatic paleoenvironments by weighting habitat preferences of freshwater mussels. This is applied to several Midwestern and Great Plains molluscan assemblages. While data presented are limited to Mississippi River basin taxa, the procedure could potentially be adapted for use in other geographic areas, or with other taxa.

Bogan and Grady report on mussels from Pleistocene cave sites in West Virginia. In contrast with Pleistocene mammalian and avian fauna from these and similar sites that indicate boreal or tundra environments, the molluscan fauna are composed of the same taxa living in the area today. Holman's review of North American reptiles and amphibians provides a similar case of apparent stability through time.

Like many *festschriften*, this volume lacks a unifying theme, other than that the articles in it are all tributes to Paul Parmalee. Furthermore, some articles, such as those by Lyman and Grayson, expand only slightly on previous publications. Although this volume will be of greatest value to those interested in the zooarchaeology and paleoecology of the Eastern Woodlands, several articles, including those by Munson, Warren, and Semken and Falk, have a significance that extends beyond geographic boundaries and should be of interest to all zooarchaeologists.

T. Cregg Madrigan
Rutgers University
Department of Anthropology
New Brunswick, New Jersey 08903

**Recovering Rights. Bowhead Whales and Inuvialuit Subsistence in the Western Canadian Arctic.** Milton M.R. Freeman, Eleanor E. Wein and Darren E. Keith (editors). Studies on Whaling No. 2, Ottawa: The Canadian Circumpolar Institute and Fisheries Joint Management Committee, 1992. Pp. 112 (41 pages of appendices). $18.00 CAD & tax. (softcover). ISBN 0-919058-79-5; ISSN 00068-0303. (Available from: Canadian Circumpolar Institute Book Distribution, G-213 Biological Sciences Building, University of Alberta, Edmonton, T6G 2E9.)

This fascinating book documents the 1991 bowhead whale hunt of the Inuvialuit community of Aklavik. This whale hunt was the first to occur for more than a half century, and was greatly celebrated. The first part of the book is a historical and socio-cultural perspective on Inuvialuit bowhead hunting, and contains chapters on the origins of the Aklavik people and their interest in bowhead hunting; factors contributing to uncertainty, change and cultural identity; contemporary Aklavik wildlife harvesting activities; and a detailed description of the 1991 bowhead hunt.

Part II describes a concurrent study on traditional food use and food preferences of the Inuvialuit. This book is well-written and of great interest to ethnobiologists involved in issues central to traditional subsistence styles of wildlife use. There are several black and white photographs documenting the whale hunt. In Part II nine tables describe the use of Inuvialuit traditional foods and market foods by adults and children, giving preference ratings and selected nutrient information.

This is an excellent case study of re-emergence of aboriginal food traditions, useful in many types of educational programs.

Harriet V. Kuhnlein
School of Dietetics & Human Nutrition
Macdonald College of McGill University
Ste. Anne de Bellevue
Province of Quebec H9X 1C0

**The Ethnobotany of Tonga: The Plants, Their Tongan Names, and Their Uses.** W.A. Whistler. Honolulu: Bishop Museum Press, 1991. Pp. 155. $49.95 (paperbound). ISBN 0–930897–57–9.

This book is a catalogue of the numerous plants recorded by Whistler during several field trips to Tonga between 1987 and 1990. Whistler presents his work as an attempt to salvage traditional Tongan knowledge of local plants in the face of increasing reliance on Western manufactured goods. He also offers his work as a foundation for additional research by ethnobotanists and anthropologists into traditional plant uses. Although the resulting book is a fairly raw presentation of the information Whistler collected during his surveys, this volume is nonetheless a useful resource for those with a specific interest in human-environmental relationships in Polynesia. This book documents not only the subsistence and material uses of plants, but also medicinal and ornamental plant uses. The book also casts light on some unintended ecological consequences of human disturbance by noting a large number of weeds that grow on the islands. In addition, Whistler's work provides insights into Tongan folk knowledge and beliefs surrounding plants.

Whistler begins the book with five extremely short introductory sections. The first section gives a "bare-bones" (less than three pages) introduction to the Tongan islands, their culture, and their history. An even shorter chapter reviews the flora of the islands and lists previous botanical surveys done in Tonga. Next is an explanation of his methodology for the project, which involved field interviews with Tongan informants and collecting voucher specimens. The following section is a

short introduction to the Tongan language, including a few notes on its relationship to other Polynesian languages and some comments on how the language is rendered orthographically. The fifth of these introductory chapters discusses the different uses of the plants Whistler has recorded and the different categories he used to classify the plants during his surveys. Whistler divided his collections into " . . . food plants, material plants, dye plants, fish poisons, ornamentals, medicinals, and 'other' " (p. 14).

The lion's share of the book is given over to the list of plants. The plant names—about 620 of them in all—are alphabetized by their Tongan names. Entries also note the island where the specimen was taken, the plant's habitat, native uses of the plant, and its origin. Also, Whistler thoughtfully provides an index of the plants' scientific names in the back of the book. Several appendices list plants that were noted in earlier botanical articles which Whistler was unable to verify in his own study, so that the substance of all major previous works is captured in this volume.

Obviously, this book is not an effort to integrate Tongan ethnobotanical data into any larger cultural or historical framework. Rather, Whistler seeks to provide a sourcebook on Tongan plant usage for other researchers. Whistler deserves congratulations for the service he has rendered to anthropologists who wish to better understand the Tongans' relationship with their environment.

However, there are some aspects of this book's presentation that could have been better. For instance, readers unfamiliar with botany will find the entries littered with arcane notes and abbreviations. This book would be more accessible to a wider audience if Whistler had taken the time to explain his entries more fully. Otherwise, the only fault I can find with the book is the omission of a Bellwood reference from the bibliography.

All in all, *The Ethnobotany of Tonga* will be a useful addition to the resources of anthropologists and archaeologists interested in Polynesia in general and Tonga in particular, although the book's price may intimidate some potential readers. The information in this volume provides insights into the role of local plants in many aspects of Tongan daily life. This book will appeal to a fairly narrow band of researchers, but they should be pleased with *The Ethnobotany of Tonga*.

Patrick Jones
Department of Anthropology
Tulane University
New Orleans, Louisiana 70118-5670

**Ethnobiological Classification: Principles of Categorization of Plants and Animals in Traditional Societies.** Brent Berlin. Princeton, New Jersey: Princeton University Press, 1992. Pp. xvii, 335. $45.00 (hardcover). ISBN 0-691-09469-1.

Brent Berlin and his many associates have long played a noticeable role in forging an interdisciplinary field of inquiry called ethnobiology. From his work on folk classification of living things and the concept of rank to his findings with regard to patterns in the names for plants and animals across many languages of

the world, Berlin has at once been one of the most innovative, controversial, and versatile scholars working in ethnobiology. He has trained several of its practitioners, has long been very active in the Society of Ethnobiology as well as related associations, and has set the tone and even invented the metalanguage for most of the major debates that have marked ethnobiology since the early 1970s. And especially with regard to ethnobotany, no substantially complete, recent studies of particular systems have been yet published that do not, in one way or another, refer to the work of Brent Berlin.

But not for these reasons should every serious student of ethnobiology read his latest contribution. This engaging book does not simply rehash earlier positions. Although it incorporates a major summation of Berlin's proposed ethnobiological principles, which were first published in 1973, it modifies some of these significantly, clarifies others, and offers new ones. The present book also suggests new directions for research. It is immediately the most significant book-length work on theory and method for the study of traditional systems of ethnobiological classification and nomenclature yet in print. And it is guaranteed to excite controversy.

The argument is framed in terms of a paradigmatic tension between the "two faces of ethnobiology" (p. 5), viz., the "utilitarianists" and the "intellectualists." Berlin credits Lévi-Strauss with the original distinction. Simply stated, utilitarianists believe, as did Malinowski, that names and classifications of living things reflect mainly material concerns. Intellectualists, at the other extreme, hold that such names and classifications spring from autonomous mental processes inherent to the human species.

One may surmise that the debate in ethnobiology between utilitarianists and intellectualists, as Berlin has phrased it, is homologous with the century-old tension in anthropology itself between cultural and linguistic relativity, on the one hand, and rationalism and evolutionism, on the other. As in some of his earlier work, especially that with Paul Kay on color taxonomy, Berlin explicitly dissociates him self from relativity here (pp. 11–13). Berlin on ethnobiology, as with Noam Chomsky on theoretical linguistics, unapologetically expounds a rationalist point of view. His main concern in this book is in demonstrating astonishing similarities among human systems of ethnobiological classification and nomenclature, similarities which stem presumably from the fact that "biological reality allows for few [interpretive] options" (p. 26) and from the biologically determined capacity of the human species to apprehend, name, and classify fundamental discontinuities in nature. In other words, constructing a comparative ethnobiology, which is one of the deliberate objectives of this book, entails recognizing in the first instance that certain perceptual properties are pan-human. The quest here is to isolate and define the natural, unconscious mechanisms that lie beneath the superficial diversity seen in folk systems of biological classification and nomenclature.

Berlin formulates twelve classificatory and nomenclatural "principles" that, *mutatis mutandis,* should apply to the gamut of traditional ethnobiological systems (pp. 21–35). He argues cogently and with ample substantiation for the universality of taxonomic hierarchy (expressed in terms of "ranks"—pp. 135–139) as well as for the salience of generic taxa (pp. 52–101) in the world's non-literate biological classifications. He offers a persuasive defense, moreover, for having previously recognized

that many taxa of kingdom-level (unique-beginner) rank are covert (unnamed) [pp. 190–195].

His argument for covert taxa of intermediate "rank" (taxa between the ranks of life form and folk generic—pp. 141–144), however, seems less compelling. First, such taxa are not nearly universal as with covert unique beginners in non-literate languages. Second, the evidence Berlin presents for covert taxa of intermediate "rank" is much weaker than that which he has given for covert taxa of kingdom-level rank. Covert taxa of kingdom-level rank are understood to be real, in part, because a portion of the lexicon refers only to them. For example, among the Tzeltal, Huambisa, and Aguaruna, certain words for plant parts, life processes, and entire organisms are not extended to other arenas of life (p. 191), even though no word semantically equivalent to the botanist's "vascular plants" occurs in these languages. In other words, however they may be covert, it is difficult to deny the linguistic and cognitive evidence that unique beginners encompass fairly distinct semantic domains.

But the terms used to delimit covert intermediate taxa tend to be based on the idiom of human kinship and/or social organization—these are extremely polysemous (pp. 144–148). For example, regarding certain generic taxa, folk systems of ethnobiological classification often indicate that they are "relatives," "brothers," or "'go together,' as members of the same family" (p. 145). Considering the fluidity of family membership in many human societies (especially in lowland South America), one could make the counterargument that if such covert intermediate taxa exist as "ranks" in ethnobiology, they may be often unstable in terms of their constituent members. Nature may be fairly fixed in external appearance, but human societies are profoundly flexible.

In addition, the substantive criteria for defining covert taxa of intermediate "rank" may be inconsistent in any given language. For example, with regard to the 50 covert intermediate plant taxa Berlin documents for the Huambisa (Table 4.3), whereas most are based on "general similarities in stem habit or gross morphology" (p. 152), fully one-fourth "appear to be formed on the basis of functional, special purpose considerations" (p. 152), such as a perceived value as fuel (p. 159). Berlin is clearly trying to establish an analogy here between "covert intermediate taxa" and the biological family, itself often an artifact of taxonomic artistry and not a given in nature (unlike, for example, the biological species). In short, whereas psychological reality for covert kingdoms in ethnobiological systems is convincing, other covert groupings may still best be considered to be extrataxonomic "complexes," in the sense of Eugene Hunn (cited on p. 142), rather than taxa at the level of an established rank. In either case, controversy over this point seems likely to continue.

The most remarkable original findings surface in Chapter 6, which is subtitled "The Nonarbitrariness of Ethnobiological Nomenclature." Berlin contends that generic names for birds and fish in Huambisa exemplify sound symbolism. It is striking, indeed, that a statistically significant majority of bird names incorporates the high front vowel ([i] as in English sw*ee*t), whereas a statistically significant minority of fish names does so. In addition, the high front vowel tends to occur in the first syllable of bird names, whereas it does so only in a very small minority of fish names. Other statistically significant phonetic differences in Huambisa bird

and fish names are equally intriguing (pp. 235–240). Berlin convincingly argues that the high acoustic frequency of [i] occurs in bird names because the sound is subconsciously associated with "quick and rapid motion (i.e., 'birdness')" [p. 249]. Fish names, on the other hand, tend to incorporate sounds of low acoustic frequency that indicate "smooth, slow, continuous flow (i.e., 'fishness')" [p. 249]. In other words, the given forms of nature elicit predictable linguo-cognitive responses in humans. Although linguistic relativists will probably deny that the Huambisa evidence and a few other examples cited by Berlin suffice to claim, as does Berlin, that sound symbolism may be universally present in ethnozoological lexicons, these findings are certain to stimulate further research by others.

The final chapter gives a comprehensive review of the differences thusfar noted in the structure and size of ethnobiological lexicons associated with foraging peoples on the one hand vs. horticulturalists on the other. With the notable exception of the Seri, it now seems clear that languages associated with foraging peoples tend to exhibit very few folk specific names, no varietal names, and a small total number of generic names for plants and animals, all of which stands in striking contrast to many languages associated with horticultural peoples. Although recent materialist explanations for these differences have been advanced (most notably by Cecil Brown), Berlin is careful in noting that such differences may stem from the different habitats usually exploited by foragers vs. horticulturalists. Until a comparative ethnobiological study is conducted of foragers and horticulturalists who exploit the same habitat, according to Berlin, one would be premature to conclude that the observed differences in ethnobiological vocabularies and classifications derive from type of subsistence alone. This represents one more challenge for future researchers that this book lays down.

As for design, although the book lacks photographs, the line drawings are extremely helpful. In addition, many useful tables are logically interwoven with the text: they bolster rather than distract from the discussion. Even though the book may seem daunting at first to ethnobiologists without a background in linguistics, Berlin nicely defines the technical concepts in plain English, using illustrative examples.

In conclusion, this book constitutes an extremely instructive and insightful review of theory, method, and data in ethnobiology by one of its genuine masters. Despite the criticisms noted above, *Ethnobiological Classification* is well conceived, clearly written, and thoroughly documented. I was enriched by reading it. The book will become an indispensable tool for professionals. It will be well assigned as required reading in graduate and upper division undergraduate courses on language and culture, cognitive anthropology, anthropology theory, and, of course, ethnobiology. Ethnobiology's debt to Brent Berlin shows no signs of waning. Nor should it.

William Balée
Department of Anthropology
Tulane University
New Orleans, Louisiana 70118

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# EDITOR'S VIEW

Whether as individuals we come to ethnobiology from a natural science or social science background, I think there can be little disagreement concerning the central role fieldwork plays in our discipline. Fieldwork—research outside the lab, the library, the classroom, the process of going "out there" to try to understand how people relate to the plant and animal worlds—does anyone become an ethnobiologist without a love for this fundamental aspect of the work? As someone who spends most of her time in the lab, I would be the last to deny the importance of analyzing data, but where do those data come from? From field research—whether the data are archaeological, like the plant remains I work with, or tapes of bird calls, notebooks of plant names and uses, boxes of vouchers, bags of samples for nutritional analysis . . .

How do we teach students to do fieldwork? Some ways I am familiar with are through field schools or field techniques classes (i.e., in a semistructured to structured learning environment), by means of small practice projects (as part of a class, for example), or one-on-one with a mentor ("going to the field" with your advisor). It is the rare student who faces her first independent research project with no preparation in doing fieldwork; many do not receive this preparation until graduate school, however. This is a mistake, I think—the earlier a student begins to grasp what is involved with fieldwork, the sooner he will know whether ethnobiology is for him.

My point is that the fieldwork experience is more than just the techniques one learns. It is more than interviewing, laying out an excavation grid, collecting plants, taping bird calls. These are the mechanics. The essence of fieldwork is seeing and experiencing the interactions between people and their natural world yourself. Being there with a living culture, standing amid the remains of past cultures, walking through the ecosystem you are studying. What we study, after all, are not just the objects, the plants, the shells, the names, but the interactions of people with those objects in their cultural and natural settings. We "go there" to grasp the whole in order to understand better its parts.

For something so fundamental I think we are often haphazard about passing along fieldwork skills, and the love of the fieldwork experience, to students. It's expensive to take students to the field; they often lack the necessary language skills; they seem to create work, not help with it. But I can't think of anything more important to teach. It's the time of year when students start asking about doing fieldwork next summer—how have you passed along the fieldwork ex-

perience to your students? Send me your ideas, and I'll share them with our readers.

Will Van Asdall has generously shared his expertise in ethnobiology and the art of editing since his retirement as *Journal of Ethnobiology* editor by serving as a member of the Editorial Board. He is now stepping down from board. Thanks again for all the help, Will, and best wishes.

DMP

*J. Ethnobiol.* 13(2):149–169 Winter 1993

# THE EVOLUTION OF SEED MORPHOLOGY IN DOMESTICATED *Chenopodium:* AN ARCHAEOLOGICAL CASE STUDY

KRISTEN J. GREMILLION
*Department of Anthropology*
*The Ohio State University*
*Columbus, OH 43210–1364*

ABSTRACT.—A large body of data on several key morphological characters has been compiled through examination of collections of archaeological *Chenopodium* from eastern North America. Contrary to expectations based on change in certain other seed crops, the patterns of variation observed in *Chenopodium* do not reflect a gradual evolution of seed morphology away from the wild type. Evidence for decreasing levels of morphological variability in the evolving domesticate is likewise minimal. These findings demonstrate that the rate and character of crop evolution as revealed in the archaeological record can be expected to vary considerably among taxa.

RESUMEN.—Se ha compilado un extenso ouerpo de datos sobre varios caracteres morfológicos clave mediante el examen de colecciones de *Chenopodium* arqueológico del este de Norteamérica. Contrariamente a las expectativas basadas en el cambio en ciertos otros cultivos de semilla, los patrones de variación observados en *Chenopodium* no reflejan una evolución gradual de la morfología de las semillas en creciente distancia del tipo silvestre. La evidencia de niveles decrecientes de variabilidad morfológica en la especie domesticada en evolución es asimismo mínima. Estos resultados demuestran que puede esperarse que la tasa y el carácter de la evolución de los cultivos, tal y como se revela en el registro arqueológico, varíen considerablemente entre taxa distintos.

RÉSUMÉ.—Un large ensemble de données concernant plusieurs charactères morphologiques importants a été recueilli en examinant des collections de *Chenopodium* de l'est de l'Amérique. Contrairement aux expectatives basées sur les changements dans certaines espèces de graines cultivées, l'évolution de la morphologie des graines de *Chenopodium* à partir du type sauvage ne semble pas progressive, d'après les modèles de variation observés. Il est aussi évident que le niveau de variabilité morphologique évident dans l'évolution des types domestiqués diminue peu. Ces résultats démontrent que le rythme de modification et le charactère de l'évolution des types domestiqués, vus à travers les données archaeologiques, doivent varier considérablement entre taxa.

## INTRODUCTION

The origins and development of plant husbandry and its social, economic, and ecological consequences for past cultural systems have long been of interest to anthropologists. Consequently, much effort has been devoted to identifying the archaeological correlates of the initiation of food production. Often the best evi-

dence of this sort is found in the form of distinctive morphologies of cultigens that develop in the context of domestication, frequently as a result of the loss, reduction, or augmentation of particular anatomical structures. As a result of the utility of such traits as temporal markers for the origins of agriculture, analyses of cultigen morphology frequently emphasize their presence or absence rather than the details of their variation in space and time. However, more precise analyses of cultigen morphology do hold considerable potential as an empirical basis for inferences about various aspects of past human behavior. For example, compilations of morphometric data from the eastern United States have been used to trace the intensification of relationships between humans and weedy annuals (Fritz and Smith 1988; Smith 1987, 1989; Yarnell 1972, 1978).

Two aspects of crop evolution are especially amenable to examination using archaeological data. These are the rate and magnitude of change in characters linked to domestication (such as fruit size and seed coat thickness) and the variability exhibited by those same characters. In particular, researchers have been motivated to ask whether continuously varying traits such as fruit size changed gradually over time in a more or less linear direction, or rapidly, establishing a clear dichotomy between early and late forms. Also of interest is whether there was a tendency for domesticated populations to be less morphologically variable than their wild relatives, and if so how this might be explained as a result of selection in human-modified environments. The answers to these questions regarding the path taken by crop evolution have important implications both for the evolutionary history and ecology of particular plant species and the study of their relationships with human groups.

A large body of archaeological data from eastern North America pertinent to these research questions has accumulated in recent years. Archaeological evidence indicates that at least three weedy native annuals (sunflower, *Helianthus annuus* L.; sumpweed, *Iva annua* L.; and chenopod or goosefoot, *Chenopodium berlandieri* Moq.) were brought under domestication in the region before 1500 B.C. (Crites 1993; Smith 1987, 1989), although for chenopod the possibility of a Mesoamerican derivation remains to be fully evaluated on phylogenetic grounds (Wilson 1981, 1990). In the case of sunflower and sumpweed, evidence for domestication takes the form of a gradual increase in achene size that has been observed in archaeological material (Asch and Asch 1985b; Smith 1987; Yarnell 1972, 1978). In contrast, domesticated taxa within *Chenopodium* are primarily distinguished from their wild relatives by possession not of unusually large seeds, but of a complex of traits linked to the reduction of the seed coat. Both dark-seeded and pale varieties, which differ morphologically in the degree of seed coat reduction and the resulting color of the fruits, have been documented prehistorically in eastern North America (Fritz and Smith 1988). Although the pale phenotype is not known in wild populations (Wilson 1981), the dark-seeded cultigen is nearly indistinguishable from a form that occurs, albeit usually at low frequencies, in the wild.

This study applies morphometric data on eastern North American *Chenopodium* to the examination of the rate and character of the evolution of its cultigen forms. The problem is first addressed through documentation of changes in the thickness of the seed coat and other characters thought to be closely linked to selection in the context of domestication. Next, evidence for reduction in mor-

phological variability within domesticated chenopod populations is reviewed. Finally, the implications of temporal patterns of morphological variation in this species for human behavior are discussed.

## PREVIOUS RESEARCH

*Establishment of the domesticate status of Chenopodium.*—*Chenopodium* seeds were found by Gilmore (1931) and Jones (1936) to be both ubiquitous and abundant among organic materials from dry rockshelters in eastern Kentucky and the Ozark uplands. However, it was not until the advent of flotation recovery of archaeological plant remains in the Eastern Woodlands that *Chenopodium* was found to be common at open sites as well. As evidence accumulated indicating that this plant (along with a number of other grain-producing species) was utilized well before the appearance of maize in the archaeological record, interest was quickly renewed in the hypothesized indigenous "Eastern Agricultural Complex." It was in the context of this debate that Asch and Asch (1977) set out to examine evidence of distinctive morphology in archaeological *Chenopodium* from the region. They concluded that the rockshelter specimens studied by Gilmore and Jones fell within the range of variability for modern nondomesticated populations, despite their tendency to display atypical frequencies of certain traits (e.g., truncate fruit margins and reddish coloration). Even the criterion of seed size, so useful for determining domesticate status in many taxa, failed to distinguish the archaeological specimens from wild ones when previously misidentified seeds of poke *(Phytolacca americana)* were eliminated from consideration.

In the 1980s the cultigen status of *Chenopodium* in the Eastern Woodlands was reassessed. The result of this reevaluation, pioneered by Hugh Wilson (1981) and Bruce Smith (1984, 1985a, 1985b) was that *Chenopodium* had indeed undergone morphological change prehistorically. However, instead of increased seed size, reduction of the seed coat and associated modifications of fruit margin configuration and cross-sectional shape were found to distinguish both extant cultivars of *Chenopodium berlandieri* (especially *C. berlandieri* ssp. *nuttalliae,* a crop of highland Mexico) and their prehistoric counterparts. Especially close morphological resemblances were noted between archaeological specimens from eastern North America and the *nuttalliae* cultivars *'chia'* (a grain crop with a thin, dark seed coat) and *'huazontle'* (which is harvested before fruit maturation and has small, pale-colored fruits) (Wilson 1981, 1990). Despite these similarities, in light of the absence of prehistoric records of Mexican *Chenopodium* that predate those of eastern North America a new taxon, *Chenopodium berlandieri* ssp. *jonesianum,* was created based on descriptions of well-preserved collections from Ash Cave, Ohio and Russell Cave, Alabama (Smith 1984, 1985a, 1985b; Smith and Funk 1985). This discovery was supplemented by early (ca. 1500 B.C.) accelerator dates on *Chenopodium* seeds from the Newt Kash and Cloudsplitter rockshelters in eastern Kentucky (Smith and Cowan 1987). This finding established that the widespread and economically important cultivation of this crop during the Early and Middle Woodland periods grew out of an initial development of domesticated forms during the Late Archaic.

A synthesis of information concerning the morphology and distribution (both temporal and spatial) of cultigen *Chenopodium* (Fritz and Smith 1988) concluded

that, despite the present-day existence of conspecific cultivars in Mesoamerica, the domestication of this species occurred locally and independently in the Eastern Woodlands. However, some scholars (e.g., Wilson 1981) consider it more likely that the earliest domesticated chenopod in the Eastern Woodlands was a Mesoamerican import. It is hoped that ongoing reconstruction of phylogenetic relationships among North and South American species of *Chenopodium* based on genotypic variation in living populations (Wilson 1990) will help resolve this question.

## DATA AND METHODS

*The data base.*—Analysis of several collections of well-preserved *Chenopodium* fruits was conducted in order to detect temporal trends in seed morphology. All specimens of the cultigen type that were examined had thin, dark seed coats; the pale variety was not represented. Most of these materials represent the intensive Late Archaic and Early Woodland period occupations of several rockshelters and caves in the interior river drainages of the eastern United States (Fig. 1; Table 1). Due to exceptionally favorable conditions for the preservation of organic materials, these protected sites have been a key source of prehistoric plant remains. Study of modern samples of *Chenopodium berlandieri* was also undertaken to provide baseline data on seed morphology.

In a study of this kind, chronological placement of archaeological specimens is crucial to interpreting patterns of change and continuity correctly. For this reason, the most significant results pertain to well-dated collections. The uncalibrated radiocarbon dates reported in Table 1 are those considered contemporaneous with the collections of *Chenopodium* studied. Both samples from the Newt Kash shelter are assumed to be associated with the ca. 1500 B.C. date directly on chenopod from UMMA catalog number 16420. However, a later (ca. 700 B.C.) occupation is represented on the site as well (Crane 1956). Unfortunately, the specific context of these materials within the site is not known.

Several collections of *Chenopodium* were analyzed by the author according to the methods outlined below. In addition, data obtained from analyses by other researchers were incorporated into the present study chiefly for comparative purposes (Table 1). These sources provided important supplementary information on changing patterns of variation in *Chenopodium*. They may be consulted for more complete archaeological and methodological information.

*Analytic methods.*—The choice of morphological characters to be studied was made on the basis of both their relevance to the domestication process and the nature of the archaeological evidence. The thickness of the seed's outer epiderm (or testa) has the greatest utility as a diagnostic character for domesticated forms of *Chenopodium*. The testas of domesticated *Chenopodium* are significantly reduced, eliminating the extended dormancy ensured by presence of a thick, impermeable seed coat. Such a change is thought to occur because rapid germination is favored in the garden environment, in which sowing promotes crowding and increased competition between seedlings, and relatively early-maturing individuals are more likely to be chosen at harvest to contribute seed for subsequent plantings. In

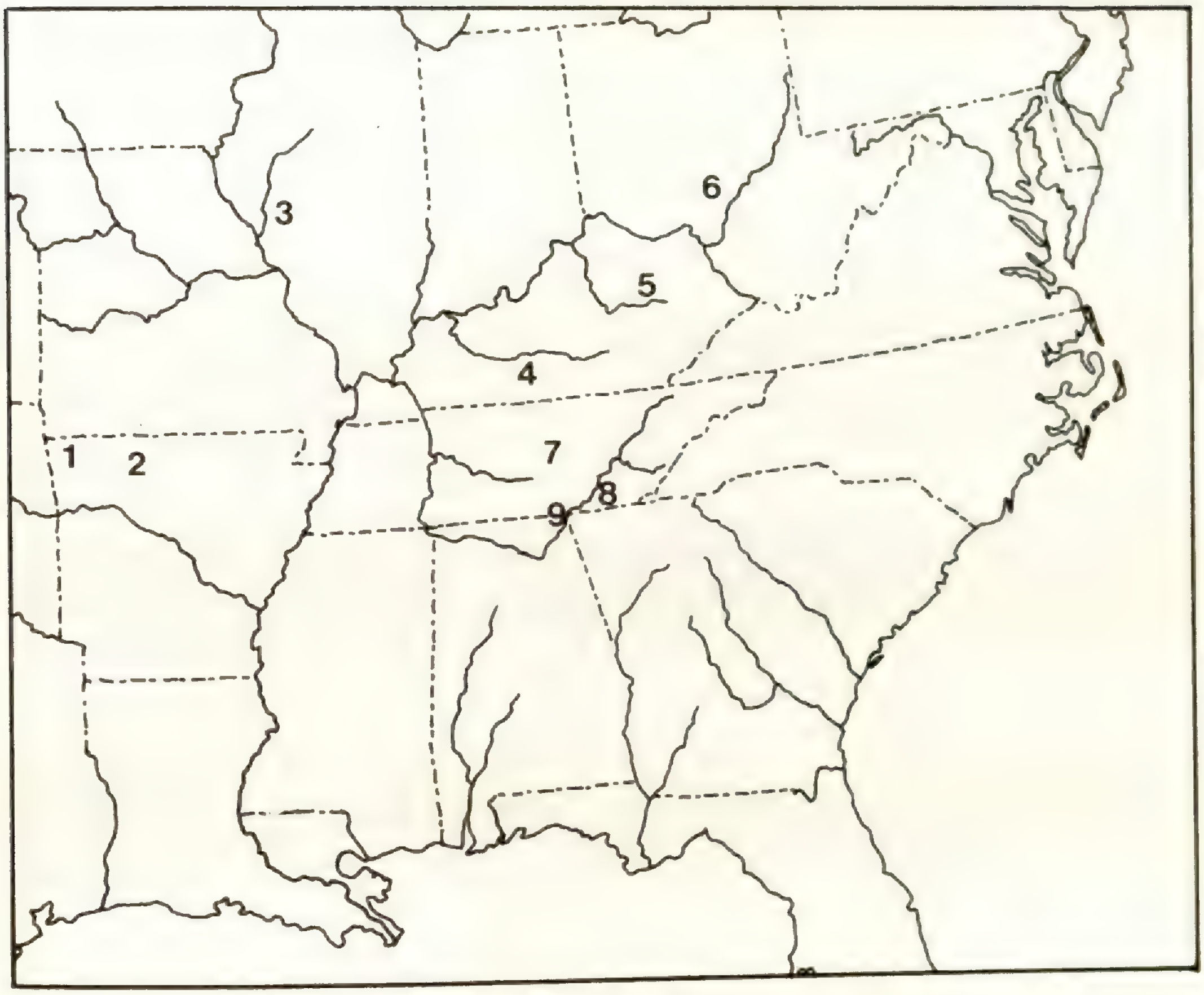


FIG. 1.—Locations of archaeological sites mentioned in text and tables. Key: 1, Whitney Bluff, White Bluff, and Edens Bluff; 2, Marble Bluff; 3, Smiling Dan; 4, Salts Cave; 5, Newt Kash, Cloudsplitter, Cold Oak, and Thor's Hammer; 6, Ash Cave; 7, Big Bone Cave; 8, Westmoreland-Barber; 9, Russell Cave.

contrast, extended dormancy or multiple germination strategies are advantageous in the wild because they increase the chances that at least some seeds will germinate when environmental conditions are favorable (de Wet and Harlan 1975:104; Harlan et al. 1973:318). Loss of the thick seed coat also removes constraints on the developing embryo, producing truncate fruit margins which contrast with the biconvex or rounded margins typical in wild populations (Smith 1985a:59; Wilson 1981:237).

A more frequently reported morphometric measurement of both archaeological and modern *Chenopodium* is seed diameter. Although this character alone cannot be used to differentiate wild from domesticated forms, seed diameter varies in a somewhat predictable fashion between members of sympatric crop/weed pairs (Gremillion 1993a; Smith 1985b). In addition, seed diameter is the character most often recorded for archaeological specimens and thus provides a large and varied data set that is useful for assessing general morphological variability.

Testa thickness of most specimens was measured with the aid of a scanning electron microscope (Cambridge S-100) located in the Scanning Electron Microscope Laboratory, National Museum of Natural History, Smithsonian Institution.

TABLE 1.—Sample information.

| Source | Context | Sample[1] | Age[2] | References |
|---|---|---|---|---|
| **I. Samples analyzed by the author.** | | | | |
| Big Bone Cave, TN | paleofeces | Specimens 1, 2, 3, and 8 | 600 ± 80 B.C.[3] | Faulkner 1991; Crothers 1987 |
| Salts Cave, KY (Upper Salts) | paleofeces | SCU-140 SCU-106 SCU-41 | 290 ± 200 B.C.– 620 ± 140 B.C.[4] | Watson 1974; Yarnell 1969 |
| Salts Cave (Vestibule) | Unit KII Level 5 | Flotation sample 1 | 250 ± 60 B.C.– 620 ± 70 B.C.[5] | Gardner 1987 |
| Cold Oak Shelter, KY | grass-lined storage pit | INV 124 | 640 ± 90 B.C.[6] | O'Steen et al. 1991; Gremillion 1993c |
| Thor's Hammer Shelter, KY | storage pit | INV 23 | A.D. 880 ± 70[5] | Gremillion 1993b |
| Cloudsplitter Shelter, KY | rock-lined storage cist | FS 2316 | 490 ± 80 B.C. | Cowan 1985a; Cowan et al. 1981; Smith and Cowan 1987 |
| Newt Kash Shelter, KY | unknown; paleofeces | UMMA 16446, UMMA 16420 | 1450 ± 150 B.C.[6] | Smith and Cowan 1987 |
| Michoacán, Mexico (Opopeo) | cultivated "chia roja" | HDW 5113A | modern | |
| Mexico State (Santa Cruz) | cultivated pale-seeded | HDW 5330 | modern | |
| **II. Published data.** | | | | |
| Russell Cave, AL | grass-lined storage pit | F.S. 23 | 390 ± 120 B.C.[6] | Smith 1985a, 1985b, unpublished notes; Fritz and Smith 1988 |
| Ash Cave, OH | storage pit | | A.D. 230 ± 100[6] | Smith 1985a, unpublished notes |
| Newt Kash Shelter, KY | various | UMMA 16440, 16441, 16444 16446, 16447 | 1500 B.C.– 700 B.C.[5,7,9] | Asch and Asch 1977; Crane 1956; Smith and Cowan 1987 |
| Smiling Dan, IL | various | | 700 B.C.– A.D. 230[5,7] | Asch and Asch 1985a; Sant and Stafford 1985 |
| Marble Bluff, AR | buried in crevice | UAM 34-23-327 | 893 ± 44 B.C.[5] | Fritz 1986 |
| Marble Bluff, AR | in woven bag | UAM 34-23-341 | 976 ± 40 B.C.[8] | Fritz 1986; Fritz and Smith 1988 |
| White Bluff, AR | gourd in storage pit | UAM 32-56-17a | 10 ± 105 B.C.[6] | Fritz 1986 |
| Edens Bluff, AR | in fiber bag | UAM 32-3-391 | A.D. 20 ± 100[6] | Fritz 1986 |

| Source | Context | Sample[1] | Age[2] | References |
|---|---|---|---|---|
| Whitney Bluff, AR | in cached gourd | UAM 32-57-3a | 1165 A.D. ± 75[9] | Fritz 1986 |
| | in cached grass bag | UAM 32-57-5c | | Fritz 1986 |
| Michoacán, Mexico | cultivated | HDW 5113, 5115, 5116 | modern | Smith 1985b |

[1]Abbreviations: Sample numbers preceded by HDW were collected by Hugh Wilson; SCU = Upper Salts Cave; UMMA = University of Michigan Museum of Anthropology; UAM = University of Arkansas Museum; FS = Field Sample; INV = Inventory number.

[2]All radiocarbon dates are uncalibrated.

[3]Accelerator date obtained from one of these paleofecal specimens.

[4]Beta decay date on other paleofeces from Upper Salts Cave.

[5]Beta decay date on associated material.

[6]Accelerator date on associated *Chenopodium*.

[7]Estimate based on a series of radiocarbon dates.

[8]Beta decay date on associated *Chenopodium*.

[9]Accelerator date on associated material.

Materials from Thor's Hammer and Cold Oak were studied at a similar SEM facility in the Department of Pathology, University of North Carolina, Chapel Hill. Specimens were affixed to stubs using either double-stick tape or a solution of white water-based glue (Elvace) and water. They were then sputter-coated with a gold/palladium mixture. Most seeds were measured at a standard magnification (450 X) and working distance (36 mm) using 10 Kv illumination. Because seed coat thickness varies somewhat between regions on an individual fruit, whenever possible measurements were taken on a cross-section of the testa farthest from the "beak" (the protrusion formed by the embryonic root, or radicle) (Fig. 2a). Modern fruits were sectioned using a single-edged razor blade. Archaeological fruits, which were more fragile, were measured along an existing break.

Margin configuration was assessed by placing each seed on its narrow edge with the beak upward and observing it under low (10 x) magnification. Each seed was then placed in a category according to the form of the margin at the lowermost part of the field of view (Fig. 2b). Criteria for classification were based on illustrations in Smith (1985b, Fig. 1). It was noted that seeds might display a somewhat different margin configuration after sectioning. Consequently, all assessments of this character were made prior to sectioning in the manner described above.

Maximum seed diameter was determined to the nearest 0.1 mm using a calibrated glass slide under low magnification. Because shrinkage due to carbonization appears to reduce seed diameter by only about 5% (Smith 1985b) no corrections were made to measurements of carbonized seeds, which were restricted to the sample from Salts Cave Vestibule.

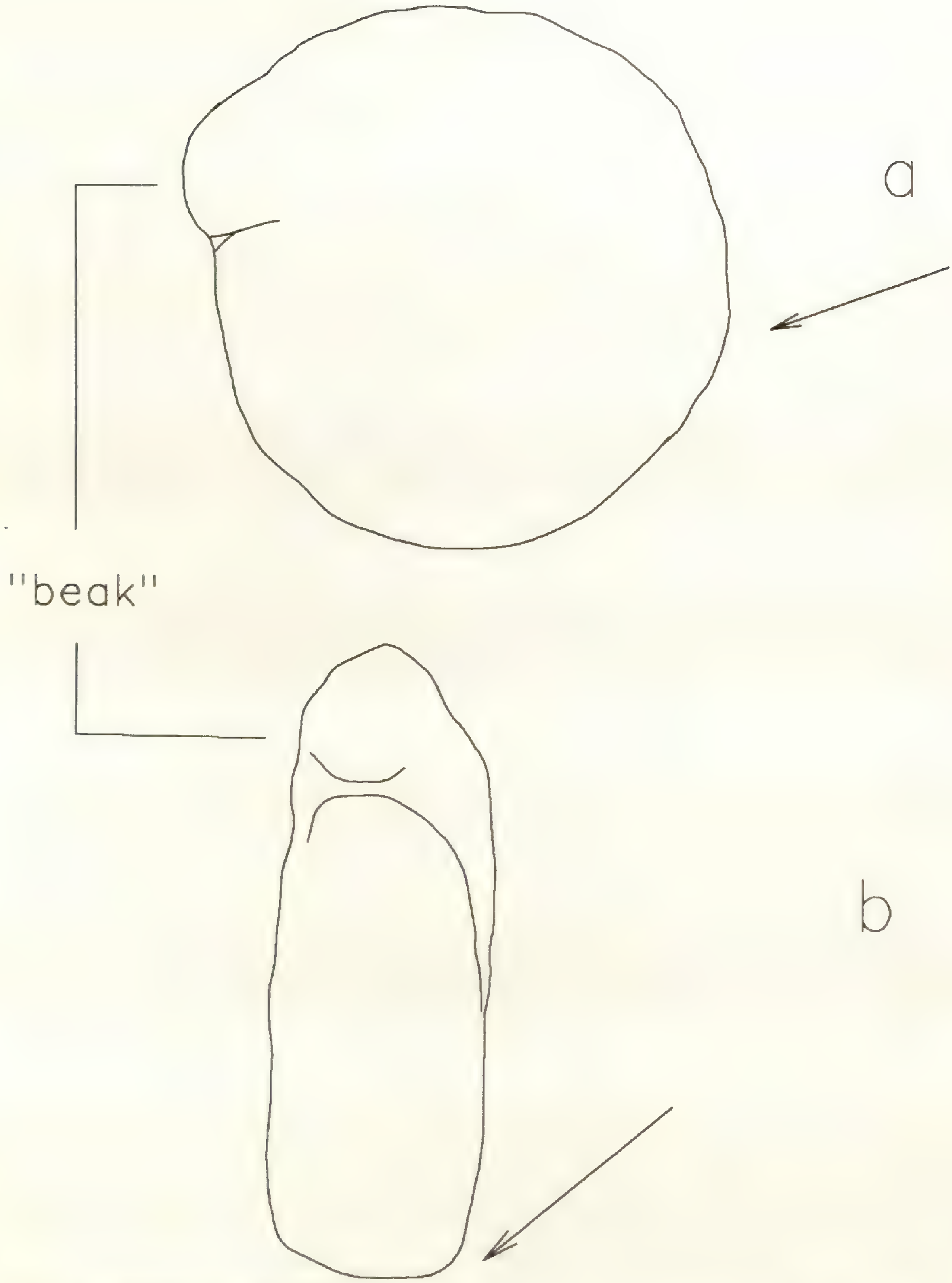


FIG. 2.—Regions of *Chenopodium* fruits selected for assessment of key characters. Arrows denote preferred locations for (a) measurement of testa thickness (dorsal view) and (b) assessment of margin configuration (lateral view with dorsal surface to the right).

*Subsampling and seed categories.*—In the case of archaeological *Chenopodium* seeds, all specimens from a given provenience intact enough to permit assessment of the characters described above were combined to form an analytic sample. For modern populations, mature specimens were selected randomly for analysis. Further subdivision was applied to those archaeological samples that were clearly dimorphic. The "weed morph" exhibits a suite of characteristics associated with free-living (e.g., wild and/or weedy) *Chenopodium* but not with contemporary domesticated populations. These characteristics include a thick and prominently patterned testa, lack of a prominent beak, black coloration (in uncarbonized specimens), and biconvex or rounded fruit margins. Only specimens exhibiting all of these traits were eliminated from the cultigen category. The appropriateness of this analytic distinction is supported by the statistically significant differences in diameter and testa thickness between the two morphological types (Gremillion 1993a).

## TEMPORAL TRENDS IN PLANT HUSBANDRY AND CROP EVOLUTION

The fact that domestication often produces morphological change in plants has long been recognized (Darwin 1859:21). Although they vary in structural detail from species to species, the morphological traits that distinguish domesticates from their wild relatives all enhance survival and reproduction in human-managed environments. Thus, they share certain structural features related to life-cycle characteristics advantageous in these environments. These features include reduction of dormancy, enhancement of seedling vigor, and loss of natural dispersal mechanisms (Donald and Hamblin 1983). Another trend frequently recognized as an outcome of domestication is reduction of genetic variability within crop populations (Bennett 1970). This trend may reflect the relative predictability and homogeneity of the human-managed ecosystem as well as intentional selection of consistently favored traits in seedstock.

The rate and character of evolutionary change in crop populations is the product of the complex interactions between heritable traits and their phenotypic expression in particular environments. Genetic change does not necessarily result in corresponding alteration of phenotypic characteristics, and morphological variation need not represent an underlying genetic cause. Despite this imperfect relationship between the operation of selection upon seed characters and their phenotypic expression, good theoretical and empirical justification exists for linking certain aspects of morphology with selection under domestication. Thus, the archaeological record can be enlisted as one source of evidence for crop evolution.

*Change in characters linked to domestication.*—Reduction of germination dormancy and enhancement of stored food reserves in seeds are thought to be linked to evolution in human-managed habitats, in which early-germinating, rapidly-growing seedlings have a significant survival advantage (de Wet and Harlan 1975:104; Harlan et al. 1973:318). Thus in *Chenopodium*, the appearance of these characteristics in high frequencies implies some degree of human management. In addition, intensification of selection for these traits over time should be reflected in a gradual increase in their frequency and/or in an incremental decrease in seed coat thickness in archaeological samples.

TABLE 2.—Testa thickness statistics, domesticated *Chenopodium*.

| Period | Site/Sample | Testa Thickness (Microns) Mean | S.D.[1] | C.V.[2] | n |
|---|---|---|---|---|---|
| Late Archaic (1500–1000 B.C.) | Newt Kash (16420) | 15.8 | 2.0 | 12.7 | 10 |
| | Newt Kash (16446) | 20.7 | 11.7 | 56.4 | 10 |
| Early Woodland (1000–300 B.C.) | Salts Vestibule | 10.5 | 5.5 | 52.8 | 11 |
| | Upper Salts | 13.3 | 4.9 | 37.1 | 38 |
| | SCU-140 | 13.8 | 4.8 | 34.6 | 8 |
| | SCU-106 | 13.9 | 5.7 | 41.2 | 20 |
| | SCU-41 | 11.7 | 3.0 | 25.6 | 10 |
| | Cold Oak | 13.0 | 2.6 | 30.9 | 14 |
| | Cloudsplitter | 13.0 | 2.6 | 20.3 | 14 |
| | Russell Cave | 11.3 | 2.8 | 23.8 | 20 |
| | Big Bone Cave[3] | 21.2 | 4.7 | 22.3 | 35 |
| Middle Woodland (200 B.C.–A.D. 500) | Ash Cave | 14.9 | 3.0 | 20.3 | 20 |
| Late Woodland (A.D. 500–1000) | Thor's Hammer | 13.9 | 4.9 | 35.5 | 21 |
| Modern cultivars | HDW 5113, 5115 | 16.3 | 3.8 | 23.1 | 20 |
| | HDW 5113A | 18.6 | 3.5 | 18.6 | 10 |

[1]s.d. = Standard deviation

[2]c.v. = coefficient of variation

[3]Specimens 1, 2, and 3.

Early prehistoric domesticated chenopod from the Eastern Woodlands varies in the extent to which it reflects selection for reduced dormancy during incipient stages of domestication (Table 2). One sample from Newt Kash shelter (UMMA 16446) displays relatively high mean testa thickness values. Similarly, *Chenopodium* from Marble Bluff shelter in northwestern Arkansas dating to ca. 1000 B.C. was described as having somewhat thicker seed coats than later collections (Fritz 1986:83). Both samples are among the most ancient that have been studied. On the other hand, some of the material from Newt Kash and Cloudsplitter compares favorably in overall morphology with modern Mexican cultivars. Thus, although some early material resembles wild forms (whose testa thickness typically averages above 40 microns; Smith 1985b), other collections (including the earliest known thin-testa fruits) are virtually indistinguishable in this respect from modern cultivars.

The absence of a directional trend is demonstrated by the correlation between testa thickness and estimated sample age for data in Table 2, which is near 0 ($r = -0.05$, $p = 0.88$, $N = 12$) (Fig. 3a). Thus, there is no evidence that seed coat thickness was reduced in a gradual, linear fashion in the past. Throughout the Woodland period (ca. 1000–300 B.C.), mean testa thickness values remain primarily in the 10–20 micron range. In fact, no archaeologically visible changes in this character are

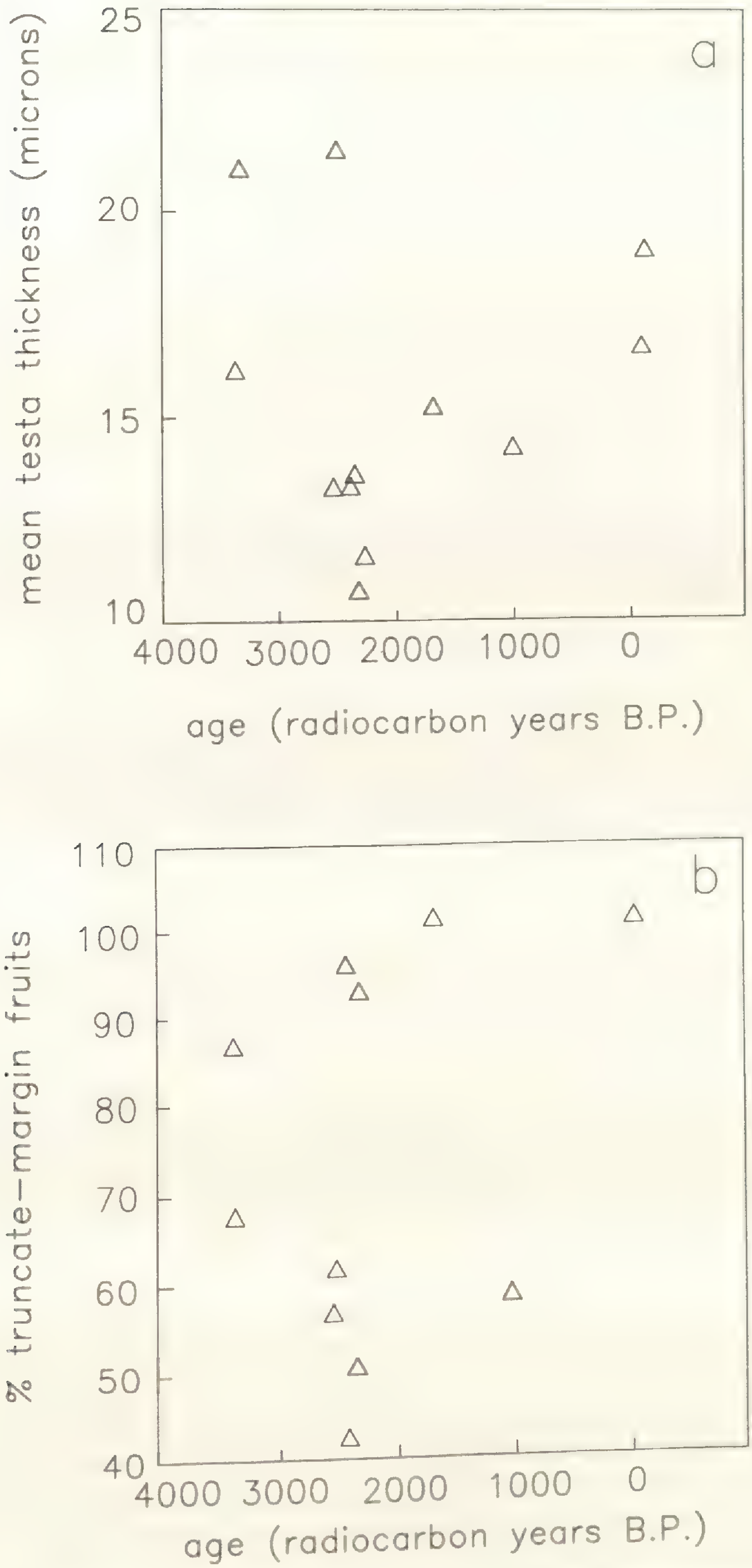


FIG. 3.—Plots of sample age against (a) mean testa thickness and (b) percentage truncate-margin fruits for collections of cultigen chenopod. (a) n = 12, r = -0.05, p = 0.88; data appear in Tables 1 and 2; (b) n = 12, r = -0.42, p = 0.18; data appear in Tables 1 and 3.

TABLE 3.—Margin configuration types, domesticated *Chenopodium*.

| Period | Site/Sample | Margin Configuration (percentage of specimens)[1] T | T/R | R | E/B | B/A | N |
|---|---|---|---|---|---|---|---|
| Late Archaic (1500–1000 B.C.) | Newt Kash (16420) | 67 | 13 | 20 | — | — | 15 |
| | Newt Kash (16446) | 86 | 10 | 3 | — | — | 29 |
| Early Woodland (1000–300 B.C.) | Salts Vestibule | 50 | 17 | 33 | — | — | 6 |
| | Upper Salts | 42 | 11 | 38 | 9 | — | 90 |
| | Cold Oak | 56 | 19 | 18 | 7 | — | 134 |
| | Cloudsplitter | 95 | 3 | 2 | — | — | 62 |
| | Russell Cave | 91 | — | 2 | 7 | <1 | 387 |
| | Big Bone Cave | 61 | 15 | 24 | — | — | 33 |
| Middle Woodland (200 B.C.–A.D. 500) | Ash Cave | 100 | — | — | — | — | 24,856 |
| Late Woodland (A.D. 500–1000) | Thor's Hammer | 58 | 13 | 14 | 15 | — | 122 |
| Modern cultivars | HDW 5330 | 100 | — | — | — | — | 50 |
| | HDW 5113A | 100 | — | — | — | — | 50 |

[1]T = truncate; T/R = truncate/rounded; R = rounded; E/B = equatorial banded; B/A = biconvex acute.

apparent until the development of pale-seeded varieties as early as ca. A.D. 300 (Fritz and Smith 1988).

Like testa thickness, margin configuration also appears to be sensitive to human-mediated environmental change. This character (quantified as percentage of truncate-margin fruits) exhibits a stronger but still not statistically significant relationship to time period ($r = -0.42$, $p = 0.18$, $N = 12$; see Table 3 for data) (Fig. 3b). Unlike testa thickness, however, frequency of margin configuration types in most archaeological samples differs markedly from that found in modern cultivars. Collections dating to before about 500 B.C. exhibit a wide range of variation in percentage of fruits with truncate margins. Only after that time do some samples (e.g., Cloudsplitter) replicate the 100% truncate pattern typical of modern Mexican cultivars. However, this contrast may simply reflect the disparity between archaeological and modern sample derivation; only the modern material is known to have been derived from single plants or populations.

The absence of a clear directional trend in morphological change for *Chenopodium* contrasts with patterns observed in sunflower and sumpweed, in which seed size is the key criterion for domesticate status. Summary data for those taxa indicate a steady, if not entirely linear, increase in achene size beginning as early as ca. 2000 B.C. (Smith 1987, Fig. 1-2). This gradual process appears to intensify around A.D. 500 for both species, with seed size curves rising sharply thereafter. The acceleration of seed size increase in sunflower and sumpweed is roughly contemporaneous with the establishment of farming economies in the Eastern Woodlands and the widespread appearance of cultigen remains in storage con-

texts. Thus, both trends are probably related to the intensification of plant management techniques such as careful selection of seedstock.

What factors might account for this difference in the evolutionary pathway taken by chenopod and two species with which it probably coexisted in prehistoric gardens? One potentially important variable is the genetic basis of seed morphology in these taxa. In *Chenopodium,* seed coat thickness is highly plastic. Although this character is under some degree of genetic control, in some *Chenopodium* species its expression is environmentally triggered (Harper et al. 1970; Williams and Harper 1965). Thin-testa fruits are present in minor frequencies in wild populations of *C. berlandieri/bushianum* and in certain environmental contexts they are numerically dominant (Asch and Asch 1977). This plasticity may have provided a basis for the very rapid establishment of the thin-testa trait at high frequencies in early protodomesticate populations (Asch and Asch 1985b). The subsequent evolutionary success of domesticated populations would have been ensured given some degree of heritability of the thin-testa/rapid germination trait complex.

Species-specific inheritance patterns and population biology may thus explain the initial rapid establishment of morphologically distinctive populations of *Chenopodium.* Somewhat more difficult to explain is the apparent absence of a gradual trend toward increasingly thinner seed coats paralleling the seed size increase in sunflower and sumpweed. However, several contributing factors can be identified. First, there is no reason to assume that an infinite number of intermediate character states are possible for testa thickness in all *Chenopodium* populations. Instead, limitation to only a few alternative phenotypes may have rendered selection for increasingly thinner testas impossible. Second, phenotypic plasticity is a complicating factor. Because the alternate phenotypes in wild *Chenopodium* do not necessarily reflect underlying genetic differences, removal of one morph from a population would not prevent its reappearance in subsequent generations (Harper et al. 1970:341). In practical terms, selective planting of thin-testa fruits will not immediately result in elimination of wild-type seeds. Thus although some genetic control of seed morphology in *Chenopodium* can be assumed, the plasticity of key seed characters with respect to environmental variables may have acted to buffer directional selection (Harper 1977:72).

*Morphological heterogeneity.*—It has frequently been noted that genetic diversity is lower in domesticated plants than in their wild relatives, a difference that is accentuated by modern economic development geared toward maximizing yields (Baker 1972:34; Bennett 1970:121, 124; Brush et al. 1988; Harlan 1975:163–167). Diversity increases under domestication primarily by way of the development of morphologically distinct cultivars or in the form of persistence of highly divergent varieties that would be selected against in the wild (Harlan 1975:109–110). Thus although domesticated species may be taxonomically diverse, individual cultivar populations tend to be rather uniform. Selective breeding, separation of cultigens from related wild populations, and (in modern times) introduction of highly uniform seedstock are responsible for these patterns. Thus, if morphological variability is found to remain high throughout the sequence represented by archaeological material, practices such as isolation and selective breeding were

TABLE 4.—Fruit diameter statistics, prehistoric domesticated *Chenopodium*.

| | Maximum Fruit Diameter (mm) | | | |
|---|---|---|---|---|
| Sample | Mean | S.D. | C.V. | N |
| Newt Kash (16420) | 1.96 | 0.17 | 8.67 | 18 |
| Big Bone Cave | 1.79 | 0.13 | 7.00 | 52 |
| Salts Cave Upper | 1.75 | 0.17 | 9.62 | 104 |
| Cold Oak | 1.81 | 0.15 | 8.28 | 135 |
| Thor's Hammer | 1.79 | 0.23 | 12.81 | 127 |
| Cloudsplitter | 1.80 | 0.13 | 7.51 | 62 |
| Russell Cave | 1.32 | 0.13 | 9.84 | 525 |
| Ash Cave | 1.87 | 0.15 | 8.02 | 1,000 |
| Newt Kash (misc.) | 1.88 | 0.21 | 11.17 | 85 |
| Smiling Dan | 1.57 | 0.15 | 9.56 | 24 |
| Marble Bluff (341) | 1.48 | 0.17 | 11.49 | 26 |
| Marble Bluff (327) | 1.60 | 0.17 | 10.63 | 200 |
| White Bluff | 1.58 | 0.10 | 6.33 | 100 |
| Edens Bluff | 1.66 | 0.11 | 6.63 | 125 |
| Whitney Bluff (3a) | 1.90 | 0.13 | 6.84 | 73 |
| Whitney Bluff (5c) | 1.82 | 0.16 | 8.79 | 55 |
| Newt Kash (16446) | 1.74 | 0.17 | 9.59 | 31 |
| Salt Cave Vestibule | 1.46 | 0.14 | 9.78 | 9 |

probably limited in frequency or degree. Reduced variety within samples over time will instead indicate some intensification of these practices.

In order to evaluate the hypothesis that domesticated chenopod became less morphologically variable over time, coefficients of variation were computed for testa thickness (Table 2) and diameter (Table 4). The coefficient of variation (standard deviation/mean × 100) is a useful measure of variability within a sample because it expresses standard deviation as a percentage of the mean. If later populations were less morphologically homogeneous than earlier ones, they should have significantly lower coefficients of variation for traits such as testa thickness. In addition, fruit size, although not a valuable yardstick for domestication, might be expected to show a similar reduction in variability.

For purposes of this analysis, the age of each sample was based upon available radiocarbon determinations (Table 1). When necessary, series of dates were converted to estimates by averaging the two extreme values. Modern specimens were eliminated from this analysis because of the likelihood that differences in variability between modern and prehistoric samples are partly attributable to factors other than chronological placement and the evolutionary processes thus implied. For example, modern samples were generally derived from single plants or populations, whereas the origin of archaeological material remains unknown and, thus, may represent a much larger and more varied gene pool.

Only a weak correlation between testa thickness coefficient of variation and sample age was noted for domesticated *Chenopodium* ($r = 0.28$, $p = 0.38$, $n = 12$) (Fig. 4a). Initial results similarly revealed no significant correlation between seed

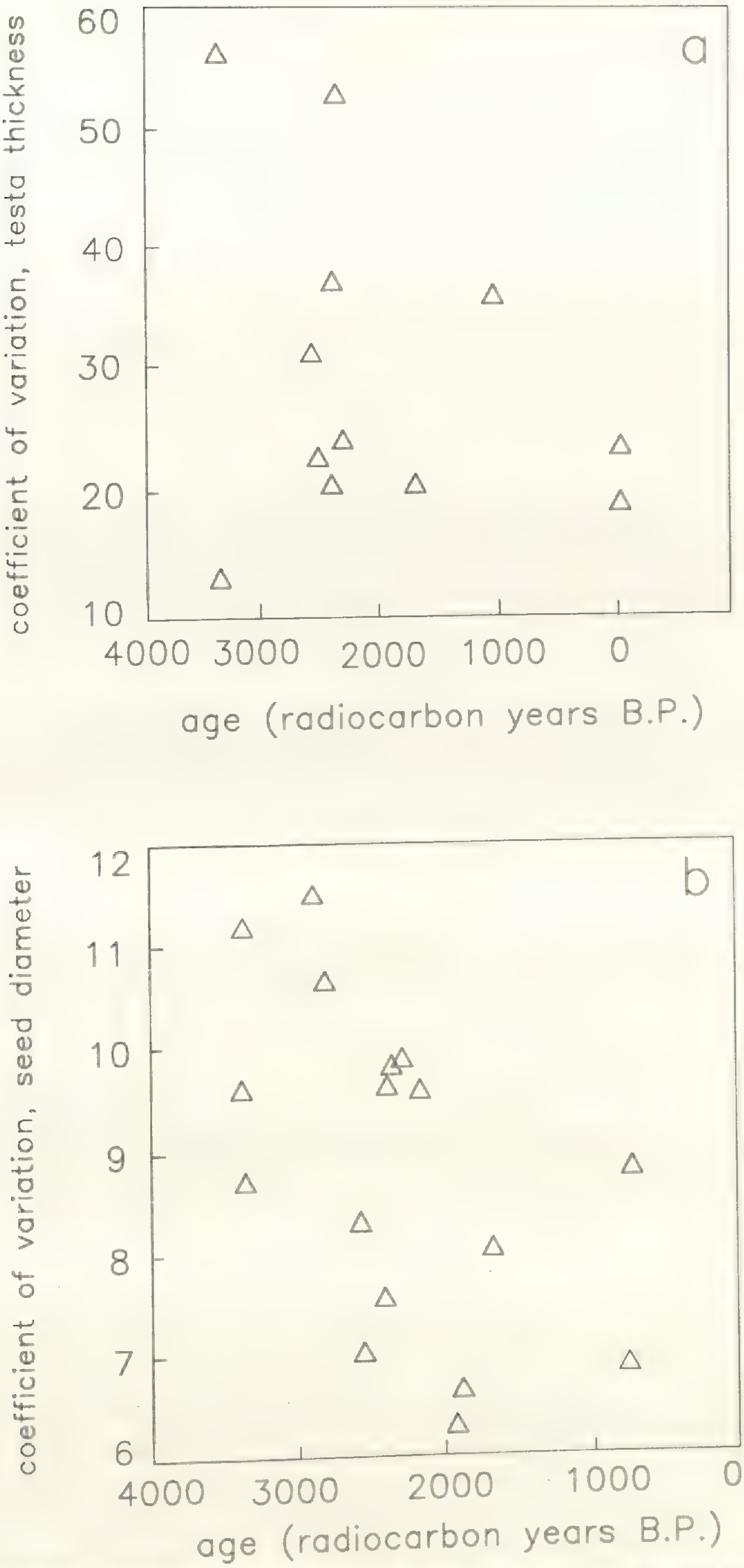


FIG. 4.—Plots of sample age against coefficient of variation for (a) testa thickness and (b) seed diameter for collections of cultigen chenopod. (a) n = 12, r = 0.28, p = 0.38; data appear in Tables 1 and 2. (b) n = 17, r = 0.53, p = 0.03; data appear in Tables 1 and 4; Thor's Hammer outlier omitted from an original sample of 18 collections.

diameter coefficient of variation and sample age ($r = 0.22$, $p = 0.37$, $n = 18$). However, analysis of residuals revealed the presence of an outlier. Removal of this case (Thor's Hammer) greatly strengthened the association between the two variables ($r = 0.53$, $p = 0.03$, $n = 17$) (Fig. 4b). Thus, comparison of coefficients of variation for two seed characters provide some support for the contention that domesticated populations of *Chenopodium* became less morphologically variable over time.

The persistence of a high degree of morphological variety in domesticated *Chenopodium* despite some tendency toward greater uniformity in seed size may be related to the presence of traits characteristic of free-living forms in cultigen gene pools. The "weed morph" sometimes identified in archaeological collections coexisted throughout much of prehistory with its cultigen counterpart (Gremillion 1993a). It has been argued that these seed categories represent distinct populations, each maintaining a different set of adaptations to human disturbance (Gremillion 1993a; Smith 1985b). Although reproductively isolated to a large extent, crop and weed populations of *Chenopodium* may have hybridized. These inferences are supported by the thickness of the seed coat in the archaeological weed morph (which tends to be intermediate between that of wild and domesticated forms) and by patterns of variation in seed size that resemble those obtained from contemporary crop/weed pairs of *Chenopodium berlandieri* (Gremillion 1993a; Smith 1985b). Additionally, the relatively high mean testa thickness of crop-type *Chenopodium* from sites such as Big Bone Cave may reflect gene flow between divergent populations. Such interaction would have interfered with any tendency for characters such as testa thickness, fruit shape, and fruit size to become canalized along certain lines. Maintenance of homogeneous cultivars would have been a particular challenge for *Chenopodium,* which is not only wind-pollinated but is represented by a series of wild and frequently interfertile taxa over most of the Eastern Woodlands. Similar difficulties for sumpweed (Cowan 1985b) may have been ameliorated by the more restricted geographical range of wild conspecifics.

## DISCUSSION AND CONCLUSIONS

Several conclusions about the evolution of *Chenopodium* as a domesticate in eastern North America emerge from this examination of diachronic variation in morphology. The first of these center around the process of domestication and how it varies with the ecological and genetic characteristics of the plants involved. The evolutionary pathway taken by *Chenopodium* contrasts with patterns observed for two other indigenous seed crops known to have been domesticated before 1500 B.C., sunflower and sumpweed. For example, no gradual long term changes in the expression of traits most closely linked to the domestication process (e.g., seed coat thickness and fruit margin configuration) can be documented. In contrast, sumpweed and sunflower both exhibit a trend toward increasing achene size over some two millennia (Fritz 1986; Smith 1989; Yarnell 1972, 1978). In *Chenopodium,* initial human-mediated environmental changes caused thin-testa fruits to have a selective advantage in gardens. Perhaps due to the presence of the thin-testa phenotype in wild populations, that trait became quickly established at high frequencies. Thereafter, mean testa thickness remains fairly constant over many

centuries. Thus, a relatively sudden shift in the traits most closely linked to selection in human-modified habitats occurred rather than gradual, incremental change. Equally abrupt as measured by archaeological data is the appearance of the pale cultivar, which seems to be the next important landmark in *Chenopodium* evolution.

Heterogeneity (as measured by variation in fruit size and testa thickness within archaeological samples) similarly shows only a weak tendency to decrease as agricultural systems evolved. The seed characters most closely associated with domestication, testa thickness and margin configuration, change little over time. On the other hand, variability in seed size does seem to have been significantly reduced, perhaps reflecting the development of simultaneous ripening or some related outcome of the domestication process. Despite this evidence for increasing control over *Chenopodium* populations, the generally high degree of morphological variability in prehistoric *Chenopodium* may indicate that techniques of plant management were still in an incipient stage of development. It may also reflect hybridization between crop and weed populations in small gardens whose diverse plant communities were managed by humans in a relatively casual fashion. By analogy with small-scale agricultural systems of the present day, plant husbandry led to the evolution of landraces and cultivars (such as the pale forms) over a broad region. However, the occurrence of weed forms suggests that Woodland period peoples of the eastern United States also faced many of the same challenges that are involved in maintaining the integrity of modern varieties. These include the propagation of crop strains with desirable characteristics, the management of noncrop species sharing the agricultural habitat, and the effective storage of seed.

Environmental uncertainty may also have limited the degree of homogeneity reached by developing crops, even in the context of human protection and management. Increasing human control over the plant habitat reduces the selective advantage of flexibility by diminishing environmental uncertainty (Rindos 1984: 185). Flexibility of response to environment, which is itself under genetic control (Bradshaw 1965:119), is therefore expected to decrease under domestication; in contrast, phenotypic plasticity characterizes the typical weed strategy (Baker 1974:8; Bradshaw 1965:127–128). The relative predictability offered by human management is also prerequisite to the loss of genetic variability that occurs under domestication, which limits the plant population's ability to cope successfully with a wide range of environments (Bennett 1970:124). The fact that cultigen forms of *Chenopodium* remained morphologically variable thus suggests that agricultural habitats were not managed rigorously enough to eliminate the advantages of flexibility of response at both the individual and population levels.

Despite the general absence of gradual change in *Chenopodium* morphology, the timing of the appearance of distinctive forms and chronological patterning in the representation of various margin configuration types provides some basis for a reconstruction of the evolution of this crop. Thin-testa *Chenopodium* at ca. 1000 B.C. was still somewhat variable in margin configuration and seed coat thickness, although clearly outside the range of modern wild populations. However, the earliest known collections also include forms quite similar to modern Mexican cultivars. The morphological evidence is thus consistent with both the convergent evolution and single origin hypotheses for the domestication of *C. berlandieri;*

however, the latter interpretation is weakened by the failure to identify any second millennium B.C. source for this hypothesized northward dispersal (Fritz and Smith 1988:13). Two additional types of *Chenopodium* become visible in the archaeological record between 500 B.C. and A.D. 300: the weed and the pale cultigen. Distinctly dimorphic collections composed of both weed and cultigen seed types do not predate the establishment of domesticated *Chenopodium* as an abundant component of seed assemblages. Patterns of archaeological occurrence of the weed form may therefore indicate increasing environmental disturbance and the simultaneous creation of garden habitats. Continuing hybridization with weed forms (as at Big Bone Cave), as well as regional diversity in the tempo of the evolution of the crop, is also reflected in Early and Middle Woodland collections. Beginning around the same time (or perhaps earlier), farmers were able to maintain cultivars that were fully dependent upon human management for survival. The fact that these pale forms did not appear earlier suggests that their establishment as crops awaited the development of more effective husbandry and/or storage techniques.

*Chenopodium* reached its height of popularity as a crop at different times in different areas. In eastern Kentucky rockshelters, it played an important role in small-scale agriculture as early as ca. 500 B.C. (Gremillion 1993c). In west central Illinois, its seeds are most abundantly represented in the form of charred masses from Late Woodland contexts, although they are also an important component of starchy seed assemblages from earlier periods (Asch and Asch 1985b:183). A similar pattern appears in the American Bottom and southward to the Arkansas River valley, where *Chenopodium* and other native starchy seed crops peak in abundance only after about A.D. 500 (Fritz and Kidder 1993; Johannessen 1984). *Chenopodium* continued to be an important crop in many parts of the Eastern Woodlands well into the Late Prehistoric period (after A.D. 1000), although by that time it (along with other native crops) had been largely displaced by maize in the Middle Ohio Valley (Wagner 1987). In the Ozark uplands, *Chenopodium* first became an important crop during the first centuries A.D. and continued that role until at least A.D. 1200 (Fritz 1984, 1986). Groups in the lower Mississippi Valley and the mid-Atlantic coast apparently still grew *Chenopodium* at the time of European contact (Asch and Asch 1977; Harriot 1972). Interestingly, after about A.D. 500, weed forms are found more abundantly in contexts suggesting heavy utilization. For example, at the Westmoreland-Barber site in southeastern Tennessee large quantities of weedy *Chenopodium* were deposited along with maize remains in a deep refuse-filled pit dated to ca. A.D. 600 (Gremillion 1993a; Gremillion and Yarnell 1986).

Morphological analysis of prehistoric crop remains, though limited in some respects, has significant value as an empirical basis for inferences about garden ecology and plant husbandry practices. By exploring relationships between morphological change, selection, and human behavior, it is possible to construct hypotheses regarding the past relationships between human and plant populations. Although the present analysis is limited to a single species, it reflects to some extent general horticultural patterns. It is hoped that studies of other taxa represented archaeologically, along with continued analyses of genetic and morphological variation in modern populations, will continue to enhance our knowledge of prehistoric agriculture in the Eastern Woodlands of North America.

## NOTE ON CURATION

All samples analyzed by the author are currently curated at the Paleoethnobotany Laboratory, Department of Anthropology, The Ohio State University, except for material from Big Bone Cave, which is held by the Tennessee Department of Conservation. Materials from the Cold Oak shelter and Thor's Hammer shelter are to be permanently curated at the University of Kentucky Museum of Anthropology.

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# BOOK REVIEW

**Fleurs de Paroles: Histoire Naturelle Palawan (Volumes I–III).** Nicole Revel. Paris, France: Peeters-Louvain-Paris, 1992. Volume I, **Les Dons de Nägsalad,** Pp. 391; Volume II, **La maîtrise d'un savoir et l'art d'une relation,** Pp. 354; Volume III, **Chants d'amour/chants d'oiseaux,** Pp. 208. ISBN 2–87723–022–8 (Volumes I, II), 2–87723–033–3 (Volume III). (Price per volume approximately $60.00 U.S.)

This 3-volume series represents a significant contribution to our knowledge of a traditional people of insular Southeast Asia, and a major addition to the literature on ethnobiology and ethnoscience in general. The book stems from 18 years' fieldwork, which is reflected in the remarkable depth and thoroughness of the treatment.

The books deal with the Palawan people of the southeastern part of the island of Palawan in the Philippines. This mountainous island is one of the most isolated and least acculturated parts of the country, and the peoples there are among the least studied. The Palawan people are an agricultural Austronesian people, one of the few native groups in the Philippines using an ancient syllabic script.

The first volume of this series is of the most direct interest to ethnobiologists. It contains information and analysis of ethnotaxonomy and ethnoanatomy of a wide variety of plants, animals, and fungi found on the island. Several different classification schemes are presented based on different criteria. Not only is there a hierarchial life-form-based classification scheme but also a "male/female" characterization based on factors such as texture and color, as well as a classification based on utilization. Information is also presented on native methods of plant identification. There are line drawings of several plant and animal species illustrating how the native names for parts of these organisms are applied differently to different species. Also included are Palawan and French texts of native myths concerning the origins of various taxa.

The second volume expands these taxonomic concepts to other semantic areas. Included is a discussion of classification of diseases, spirits, food, and work patterns. The last chapter in the book is concerned with the ethnogeography and ethnoastronomy of the Palawan.

Volume III is a fascinating description of Palawan songs and poetry, complete with lyrical texts and melodic transcriptions. The author uses a structuralist approach to illustrate the relationship between various natural sounds, especially bird calls, and the patterns found in the Palawan musical repertoire. Many bird names in the Palawan language are onomatopoeic, based on bird calls, and many melodic structures in love songs are strongly influenced by such natural sounds.

All in all, the series represents a valuable contribution not to be overlooked. It is a classic that deserves a place on the bookshelf of every ethnobiologist.

Joseph E. Laferrière
Arnold Arboretum of Harvard University
22 Divinity Ave.
Cambridge MA 02138 USA

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# "WHEN EVERYTHING WAS SCARCE": THE ROLE OF PLANTS AS FAMINE FOODS IN NORTHWESTERN NORTH AMERICA

NANCY J. TURNER
and
ALISON DAVIS
*Environmental Studies Program*
*University of Victoria*
*Victoria, British Columbia*
*Canada V8W 3P4*

ABSTRACT.—Interviews with indigenous elders and literature reports indicate that plants have historically played an important role as famine and survival foods for Indigenous Peoples of northwestern North America. Over 100 species of plants are noted to have been used in any of a variety of circumstances to alleviate hunger and aid in survival in times of food scarcity. In prehistoric and early historic times, food shortages occurred periodically, usually in late winter and early spring when bad weather and other circumstances coincided with low quantities of stored foods and unexpected scarcity of fish and game. Plant foods used in times of food scarcity fall generally within four categories: regular foods whose use became more important under certain circumstances, largely due to extended availability; alternative, less preferred foods, used casually in normal times but having minimal dietary contribution except in times of food scarcity; starvation foods or products never used under normal circumstances but only consumed in times of extreme hunger or famine; and hunger suppressants and thirst quenchers, generally used during short periods of food and water deprivation. The cultural role of famine plant foods in the study area is examined.

RESUMEN.—Las entrevistas con ancianos indígenas y las fuentes bibliográficas indican que historicamente las plantas han jugado un papel importante como alimentos de hambruna y de sobrevivencia para los pueblos indígenas del noroeste de Norteamérica. Se ha encontrado que más de 100 especies de plantas han sido usadas en cualquiera de una variedad de circunstancias para aliviar el hambre y ayudar a sobrevivir en tiempos de escasez de alimento. En la epoca prehistórica y a principios del período histórico, las hambrunas ocurrían periodicamente, generalmente a fines del invierno y principios de la primavera, cuando el mal tiempo y otras circunstancias coincidían con bajas cantidades de alimentos almacenados y escasez inesperada de pesca y caza. Los alimentos vegetales empleados en épocas de escasez generalmente entran en cuatro categorías: alimentos consumidos regularmente, cuyo uso se hacía más importante bajo ciertas circunstancias, principalmente debido a su amplia disponibilidad; alimentos alternativos, menos preferidos, usados casualmente en tiempos normales pero que ofrecen una contribución dietética mínima excepto en tiempos de escasez; alimentos o productos para hambruna, nunca usados bajo circunstancias normales y sólo consumidos en tiempos de escasez extrema; y supresores de hambre y de sed, generalmente usados durante

períodos breves de carencia de alimento y bebida. Se examina el papel cultural de los alimentos vegetales para hambruna en el área de estudio.

RÉSUMÉ.—Les entrevues avec des autochtones aînés et des articles scientifiques indiquent que les plantes ont joué historiquement un rôle très important comme nourriture dans les conditions de disette et de survivance pour les peuples autochtones du nord-ouest de l'Amérique du nord. Plus de 100 espèces de plantes sont réputées d'avoir été utilisées dans des circonstances diverses pour apaiser la faim et pour aider dans les périodes de disette. Aux temps préhistoriques et aux premiers temps historiques, la disette arrivait périodiquement, généralement vers la fin de l'hiver et au début du printemps quand le mauvais temps et d'autres circonstances coïncidaient avec une réserve limitée de provisions et un manque imprévu de poisson et de gibier. Les aliments végétaux utilisés en temps de disette de vivres se classent généralement dans quatre catégories: les aliments réguliers dont l'usage est devenu plus important dans certaines circonstances, dû surtout à leur disponibilité prolongée; d'autres aliments moins préférés, utilisés infréquemment dans des circonstances normales, mais ayant une contribution diétique minimale sauf dans des périodes de disette de vivres; les aliments ou produits de fortune, jamais utilisés dans des circonstances normales, mais consommés seulement aux temps de faim extrême ou de famine; et les moyens de fortune pour tromper la faim et la soif, utilisés généralement pendant les courtes périodes de disette d'eau et de vivres. Nous examinons également le rôle culturel joué par des plantes alimentaires employées aux temps de famine dans la région de cette étude.

## INTRODUCTION

The people of mythical times were dying of hunger. They had only sagittaria-roots [*Sagittaria sagittata*] to eat. They had only small sagittaria-roots and skunk-cabbage [*Lysichitum americanum*] and . . . rush roots [?*Typha latifolia*] to eat. In the spring of the year the Salmon went up the river. They had first arrived with many companions. . . . Then the Skunk-cabbage said: "At last my brother's son has arrived. If it had not been for me, your people would have been dead long ago." Then the Salmon said, "Who is that who is talking there?" "Oh, that is the Skunk-cabbage who is talking." "Let us go ashore." They gave him five elk skins and put war clubs under his blanket, one on each side. . . . Then they carried him inland and placed him among willows (Kathlamet Text, Oregon. Boas 1901:50).[1]

Northwestern North America, particularly the Northwest Coast, is a region generally assumed to be rich in traditional food resources (see map of study area, Fig. 1). For example, in a description of Haida Gwaii (Queen Charlotte Islands), Beals and Hoijer (1959:27) note that for the Haida ". . . Both land and marine fauna are exceptionally rich . . . Coastal waters and rivers teem with fish . . . The potential food supply is consistent and dependable, for though it is less in winter, there is no season when food is really difficult to obtain. . . ." Suttles (1990:28) describes the Northwest Coast as an area ". . . providing everywhere abundant and dependable sources of food." The Interior region of northwestern North America is also considered to be well endowed with food resources, especially along the salmon rivers (Marshall 1977; Romanoff 1992; Hunn 1990; Kennedy and Bouchard 1992). Throughout northwestern North America a wide variety of both

FIG. 1.—Map of northwestern North America showing Aboriginal groups mentioned in the paper.

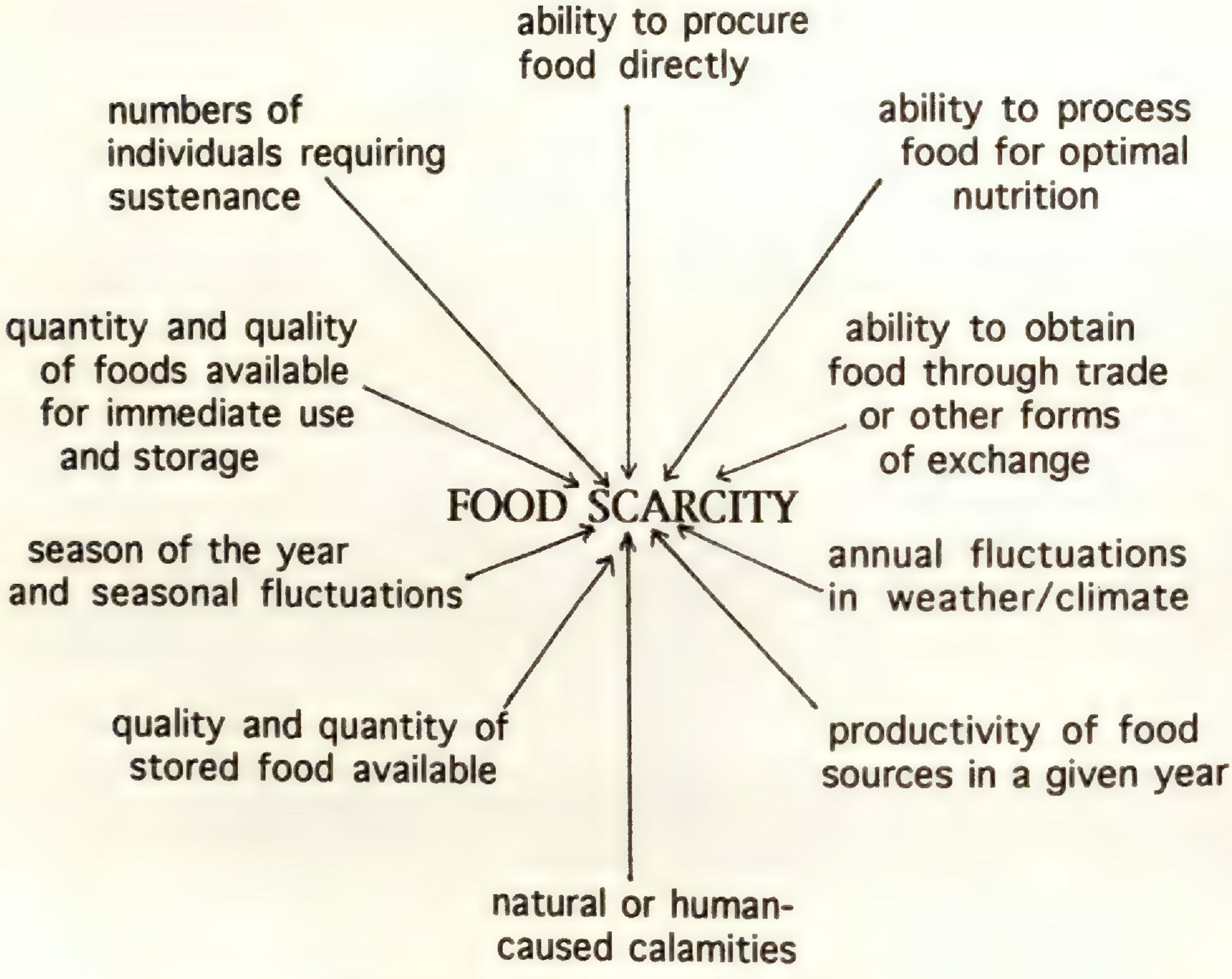


FIG. 2.—Factors influencing food scarcity.

animal and plant foods contributed to the traditional diet (Teit 1900, 1909; Turner 1975, 1978; Marshall 1977; Laforet et al. 1994; Keely 1980; Norton 1981; Hunn 1981, 1990; Hunn et al. 1994; Kuhnlein and Turner 1991).

Yet, for any group of people within the area, the ability to sustain themselves depended upon a wide variety of factors, mostly unpredictable, shown schematically in Fig. 2. Sometimes several of these factors acting together resulted in a scarcity of foods within a locality or over a broader region. If a period of severe or stormy weather occurred in a season of the year such as early spring when there were few fresh or stored food resources available, the result could be food scarcity. If stored foods were destroyed by some natural disaster such as fire or flood, or in warfare, at a time of the year when fresh food was not readily available, famine could ensue. At such times, certain plant foods, because of their more constant and reliable presence, became critical for survival. This paper explores the consumption of plant foods during times of food scarcity in northwestern North America. First, a general overview of circumstances causing food shortages within different regions and groups will be presented, followed by a discussion of different types of famine plant foods. Finally, some cultural considerations and other features of famine foods will be addressed.

*Conditions of famine among northwestern aboriginal groups.*—Famine conditions are reported from early times throughout the study region, although frequency and

severity of food shortages varied. Suttles (1987) notes generally that in places along the Northwest Coast, food scarcity could result from a prolonged stretch of bad weather, or from the failure of a fish run, combined with human failure to have accumulated an emergency food supply. Drucker (1951) and Dewhirst (1978) also report the occurrence of famine under certain circumstances among Nuu-chah-nulth (Nootka) of the west coast of Vancouver Island, particularly in early spring, sometimes as a result of a poor dog salmon or herring run followed by an unusually stormy winter or spring.

Kennedy and Bouchard (1983:25) report one instance for the Sliammon (Comox) when ". . . . the berries did not ripen, the salmon did not come and the animals seemed to have left the country" and famine resulted, but note that such occurrences are rare. For the Kwakwaka'wakw (Kwakiutl), starvation was also rather infrequent, with famine stories occurring mainly among the tribes living at the heads of the inlets of the mainland, not among those who dwell near the open sea, where seals, sea lions, salmon, and halibut are plentiful (Boas 1935).

Further north along the Pacific Coast, conditions of scarcity increased in frequency and severity. Boas (1935:171) notes that the Tsimshian were more vulnerable to famine than the Kwakwaka'wakw (Kwakiutl), a circumstance supported by other researchers (e.g., Port Simpson, People of 1983:53). Suttles (1987) speculates that the northern coast had fewer resources, but these occurred in greater concentrations, thus possibly magnifying the dangers of resource failure through human error or natural calamity. The trend towards increasing incidences of food shortage for northerly latitudes is emphasized by the work of Eidlitz (1969) for the circumpolar region.

In inland regions, the risks of food shortage were apparently greater still. The Gitksan of the Upper Skeena River, the Nisga'a of the Nass River, and the Koyukon of inland Alaska, for example, were all subject to bouts of starvation ('Ksan, People of 1980; Nelson 1983). "If the winter was longer or colder than usual, or if the salmon run was late, or the winter supply of stored food was destroyed by fire, or raiders came from the Nass, or some other calamity occurred, then things could be tough—very tough . . ." ('Ksan, People of 1980:13–14).

Teit (1909:513, 515, 517) notes "times of great famine" and "great scarcity" among the Secwepemc (Shuswap), and periods of famine due to seasonal fluctuations in salmon, deer and other game were also known to the Lillooet and Nlaka'pamux (Thompson) (Turner 1992; Turner et al. 1990; Teit 1900). Teit (1900, 1909) described several major fluctuations in populations of deer, mountain sheep, mountain goat, elk, and caribou in the Nlaka'pamux (Thompson) and Secwepemc (Shuswap) areas that certainly would have influenced food availability. Natural disasters also played a role in determining food supply. Hayden and Ryder (1991) concluded that a major prehistoric cultural collapse in the Lillooet area probably occurred due to catastrophic landslides that dammed the Fraser River disrupting salmon supplies. Hunn (1990), in his work with the Sahaptin of the Mid-Columbia, supports the general contention that winter and early spring are critical times for food shortages, and that maintaining an adequate supply of dried provisions was essential for survival.

Aside from general communal or regional food shortages that affected large

numbers of people simultaneously, there were instances where individuals and families suffered from food deprivation due to particular circumstances. For example, a hunter pursuing game may prefer to go hungry than return empty-handed, and may resort to certain emergency foods or hunger suppressants to enable him to continue. A traveller or hunter may become lost, or simply run out of food before a destination is reached. Or a family may be unlucky enough to lose a provider, and hence not be able to accumulate necessary food supplies. In all of these cases, people might resort to more easily procured but possibly less desirable sources of nourishment.

## FAMINE PLANT FOODS OF NORTHWESTERN NORTH AMERICA

*The nature of famine foods.*—Famine foods are those resorted to at times when, for whatever reason, the foods normally eaten are unavailable (Minnis 1991). As noted previously, plant foods seem to have taken on a particularly prominent role during times of food scarcity, because for those that could be harvested at lean times of the year, their availability was more predictable than that of fish or game. Plant foods used in times of food scarcity fall generally within four categories:

(1) regular foods whose use became more important under certain circumstances, largely due to extended availability;
(2) alternative or secondary foods, used minimally or casually in normal times, but used in larger quantities in times of food scarcity;
(3) true famine foods—those never eaten except in times of extreme hunger; and
(4) hunger suppressants and thirst quenchers, generally used during short periods of food and water deprivation.

Tables 1 to 4 list examples of plants within these four categories of use during times of food scarcity.

It is difficult to differentiate completely among these general categories, since there is considerable variation in the roles of particular plant foods in different regions, or even among various cultural groups and individuals. Ecotypic and chemical intraspecies variation result in different qualities and quantities of a particular food. For example, Bouchard and Kennedy (1977) note that the tiger lily *(Lilium columbianum)* bulb varies in taste depending on the particular area in which the plant is growing. Cow-parsnip *(Heracleum lanatum)* is also known to vary in flavor and quality from one area to another (Kuhnlein and Turner 1987). Different cooking and preparation techniques affect the palatability and digestibility of certain foods. (Turner 1977; Turner and Kuhnlein 1983). Boas (1921:533), for example, notes that a woman digging clover roots *(Trifolium wormskioldii)* might eat them raw when she gets hungry, but implies that the roots were much preferred cooked. Furthermore, there are cultural preferences for certain foods. Fireweed shoots *(Epilobium angustifolium),* for example, are eaten only in times of scarcity in some areas, and eaten as standard fare in others (Turner 1975). Furthermore, mature fireweed stalks were sometimes used out of necessity, but were less preferred than the young shoots.

Black tree lichen *(Bryoria fremontii)* is another food having highly variable

preference ratings in different regions. Some people, such as the Flathead of Montana, regarded it as a luxury, especially when it was mixed with dried, powdered camas *(Camassia quamash)* (Stubbs 1966). Ray (1932:104) classes it, when cooked together with alternate layers of wild onion as "one of the best liked of all vegetable preparations" among the Sanpoil-Nespelem Okanagan. Yet in other areas it was not highly regarded. This is possibly due to ecotypic variation, or to the contamination of this apparently mild-tasting species with other, more bitter species of *Bryoria*. Certainly, there are indications that the lichen varies widely in taste, depending on locality, elevation, and species of substrate tree (Turner 1977; Marshall 1977). Furthermore, preparation techniques likely influenced the palatability of the lichen considerably. It could be eaten raw and unprocessed in times of extreme need (Mary Thomas, Secwepemc elder, personal communication to NT, 1991). Under normal circumstances, however, the preparation procedures for it were complex, involving harvesting in quantity from pre-tasted populations, soaking in fresh water for several hours or overnight, pounding or working with the hands, then pit-cooking. (Marshall 1977; Turner 1977; Turner et al. 1980). The cooked "loaves" were then dried. Most people who know about this lichen agree that cooking is essential to make it edible. Cooking presumably helped to break down partially the complex lichen carbohydrates that were mostly indigestible for humans. The cooked, dried lichen that could be stored without deterioration for three or more years, was said to be a good sustainer on long journeys (Turner 1978). In times of scarcity, the Kootenay were said to boil it with the stomach contents or even droppings of the "fool hen" (grouse) for flavoring (Hart 1976). The unprocessed, raw lichen, when dry, could also be stored overwinter, to be processed and used as needed. Thus at times, and in some regions, black tree lichen could be considered a standard, "normal" and even preferred food. Under other circumstances, it would serve as an alternate food, and in some cases, it could be classified as a true famine food that was potentially toxic, or at least indigestible, when not properly prepared.

It seems that, even in the best of times, black tree lichen was not as highly regarded a food as salmon. This is reflected in the Lillooet story of "The Abandoned Boy" (Bouchard and Kennedy 1977:31), when Raven got salmon from the boy (during a food shortage), after the boy had obtained special powers from the Sun. Raven, not wanting to reveal his good fortune to the other villagers, told them that the food he had was black tree lichen bread, with the implication that this was not a particularly desirable food.

Despite such obvious discrepancies, for purposes of this paper an attempt is made to differentiate among foods within these categories. In cases such as that of black tree lichen and fireweed, these are included under more than one category in Tables 1–4.

*Standard plant foods particularly valued in times of food scarcity.*—Table 1 provides a list of plant foods of northwestern North America, eaten generally in normal times, but which have been noted in the literature, or by Indigenous elders in interviews, as having been particularly valuable or useful as survival foods in times of food shortage. Also included are plant foods known particularly for their

availability for harvesting during the winter and early spring, seasons when food shortages occurred most frequently.

Table 1 lists over 60 plant foods recognized as having had particular importance in times of scarcity, or in times when food scarcity was a highly probable occurrence. Included are 10 tree species whose inner bark was eaten, 19 green vegetable species and 30 "root" vegetables available in early spring, one lichen and one alga, as well as balsamroot seed meal and three fruits that could be found

TABLE 1.—Traditional plant foods of northwestern North America, used regularly, but particularly valuable or useful as survival foods in winter and/or early spring.

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Inner Bark** | | | |
| *Abies lasiocarpa* (Hook.) Nutt. (subalpine fir) | inner bark (occasional) | Nlaka'pamux | Turner et al. 1990 |
| *Alnus rubra* Bong. (red alder) | inner bark | Saanich, Sechelt, Coast Salish, general | N. Turner, unpublished notes, 1992, 1972, (in her possession) |
| *Picea engelmannii* Parry ex Engelm. (Engelmann spruce) | inner bark | interior peoples, general | Kuhnlein and Turner 1991 |
| *P. glauca* (Moench) Voss. (white spruce) | inner bark | interior peoples, general; Tanaina | Kuhnlein and Turner 1991; Kari 1987 |
| *P. sitchensis* (Bong.) Carr. (Sitka spruce) | inner bark | coastal peoples; Tanaina (emergencies) | Kuhnlein and Turner 1991; Kari 1987 |
| *Pinus albicaulis* Engelm. (whitebark pine) | inner bark | interior peoples, general | Kuhnlein and Turner 1991 |
| *P. contorta* Dougl. ex Loud. (lodgepole pine) | inner bark | interior peoples, general | Kuhnlein and Turner 1991 |
| *P. ponderosa* Dougl. (ponderosa pine) | inner bark | south interior peoples, general | Kuhnlein and Turner 1991 |
| *Populus balsamifera* L. (balsam poplar, cottonwood) | inner bark | Nuxalk, Lillooet, Haisla, others | Kuhnlein and Turner 1991 |
| *Tsuga heterophylla* (Raf.) Sarg. (western hemlock) | inner bark | Coast Tsimshian, other coastal and neighbouring peoples | Port Simpson, People of 1983; Kuhnlein and Turner 1991 |

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Lichens and Algae** | | | |
| *Bryoria fremontii* (Tuck.) Brodo (black tree lichen) | whole thallus | Nlaka'pamux, Lillooet and other interior peoples | Turner 1977; Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Porphyra abbottae* J. Agardh. (red laver) | whole, young plants | Coast Tsimshian and other coastal peoples | Turner 1975; Port Simpson, People of 1983 |
| **Springtime "Green Vegetables"** | | | |
| *Balsamorhiza sagittata* (Pursh) Nutt. (balsamroot, spring sunflower) | young leaves | Okanagan and other interior peoples | Turner 1978; Turner et al. 1980; Kuhnlein and Turner 1991 |
| *Epilobium angustifolium* L. (fireweed) | young shoots | Haida, Nisga'a, Lillooet and others | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *Equisetum arvense* L. (common horsetail) | young shoots | western Washington groups | Gunther 1973 |
| *E. telmateia* Ehrh. (giant horsetail) | young shoots | coastal peoples, general | Turner 1975; Kuhnlein and Turner 1991 |
| *Heracleum lanatum* Michx. (cow-parsnip, "Indian rhubarb") | young budstalks and leafstalks | northwestern peoples, general | Port Simpson, People of 1983; Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Lomatium dissectum* (Nutt.) Math. & Const. (chocolate tips) | young shoots | Okanagan; Nez Perce and Warm Springs Sahaptin | Turner et al. 1980; Meilleur et al. 1990 |
| *L. grayi* Coult. & Rose (Gray's lomatium) | stems, young shoots | Nez Perce | Marshall 1977 |
| *L. macrocarpum* (H. & A.) Coult. & Rose (desert parsley, hog-fennel, "wild carrot") | young leaves | Nlaka'pamux | Turner et al. 1990 |
| *L. nudicaule* (Pursh) Coult. & Rose ("Indian celery"; barestem lomatium) | young leaves and shoots | Lillooet, Nlaka'pamux, Secwepemc and other interior peoples | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *L. salmoniflorum* (Coult. & Rose) Math. & Const. (salmon lomatium) | young leaves | Nez Perce | Marshall 1977 |
| *Lomatium* spp. (lomatiums—general) | young greens | Sahaptin, Nez Perce | Hunn and French 1981; Hunn 1990 |

TABLE 1.—Traditional plant foods of northwestern North America, used regularly, but particularly valuable or useful as survival foods in winter and/or early spring. (continued)

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *Opuntia fragilis* (Nutt.) Haw. (fragile prickly-pear cactus) | fleshy stem segments | Nlaka'pamux, Okanagan; interior peoples, general | Kuhnlein and Turner 1991 |
| *O. polyacantha* Haw. (plains prickly-pear cactus) | fleshy stem segments | Nlaka'pamux, Lillooet, Okanagan; interior peoples, general | Turner et al. 1980; Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Rubus idaeus* L. (wild red raspberry) | young shoots | Nlaka'pamux and other interior peoples | Kuhnlein and Turner 1991 |
| *R. leucodermis* Dougl. (blackcap, wild black raspberry) | young shoots | Nlaka'pamux and other interior peoples | Kuhnlein and Turner 1991 |
| *R. parviflorus* Nutt. (thimbleberry) | young shoots | coastal and interior peoples, general | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *R. spectabilis* Pursh (salmonberry) | young shoots | coastal peoples, general | Turner 1975; Port Simpson, People of 1983; Kuhnlein and Turner 1991 |
| *Triglochin maritimum* L. (arrow-grass) | young leaf bases of vegetative plants (Note: may be toxic) | Sechelt, Comox and other coastal peoples | Turner 1975; Kuhnlein and Turner 1991 |
| *Typha latifolia* L. (cattail) | young shoots | Carrier and other peoples | Carrier Linguistic Committee 1973 |
| *Zostera marina* L. (eelgrass) | leaf bases and rhizomes | Kwakwaka'wakw and other coastal peoples | Boas 1921; Turner 1975 |
| **Some "Root" Vegetables Available in Spring** | | | |
| *Balsamorhiza hookeri* Nutt. (Hooker's balsamroot) and other *Balsamorhiza* spp. | taproots | Sahaptin and other southern Plateau peoples | Hunn 1990 |
| *Balsamorhiza sagittata* (balsamroot, spring sunflower) | taproots, side roots | southern interior peoples, general | Marshall 1977; Turner 1978; Turner et al. 1980; Turner et al. 1990; Hunn 1990 |

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *Brodiaea hyacinthina* (Lindl.) Baker [and *B. douglasii* S. Wats.] (false onion) | bulbs | Lillooet and Nlaka'pamux Sahaptin | Bouchard and Kennedy 1977; Turner 1978; Turner et al. 1990; Hunn 1990 |
| *Calochortus macrocarpus* Dougl. (mariposa lily) | bulbs | Lillooet, Secwepemc, Sahaptin, and others | Bouchard and Kennedy 1977; Turner 1978; Hunn 1990 |
| *Camassia quamash* (Pursh) Greene (common camas) | bulbs | coastal and southern interior peoples, general | Turner 1975, 1978; Marshall 1977; Turner and Kuhnlein 1983; Hunn 1990; Kuhnlein and Turner 1991 |
| *C. leichtlinii* (Baker) Wats. (giant camas) | bulbs | coastal peoples, general | Turner 1975; Turner and Kuhnlein 1983; Kuhnlein and Turner 1991 |
| *Cirsium undulatum* (Nutt.) Spreng. (wavy-leaved thistle) | taproots | Nlaka'pamux and other interior peoples | Turner et al. 1990 |
| *C. edule* Nutt. (edible thistle) | taproots | Nlaka'pamux and other interior peoples | Turner et al. 1990 |
| *C. hookerianum* Nutt. (Hooker's thistle) | taproots | Nlaka'pamux and other interior peoples | Turner et al. 1990 |
| *Claytonia lanceolata* Pursh (spring beauty) | corms | Nlaka'pamux, Chilcotin, and other interior peoples | Turner 1978; Turner et al. 1990; Hunn 1990; Kuhnlein and Turner 1991 |
| *Dryopteris expansa* (Jacq.) Woynar (spiney wood fern) | rootstocks | Northwest Coast, and some interior peoples, general | Turner et al. 1992 |
| *Erythronium grandiflorum* Pursh (yellow avalanche lily) | bulbs | Nlaka'pamux, Secwepemc, Chilcotin, and other interior peoples | Turner 1978; Turner et al. 1990; Kuhnlein and Turner 1991 |
| *E. revolutum* Smith (pink Easter-lily) | bulbs | Kwakwaka'wakw and some other coastal peoples | Boas 1921; Turner 1975 |
| *Fritillaria camschatcensis* (L.) Ker-Gawl (mission-bells) | bulbs | Haida and other coastal peoples; Nisga'a, Gitksan | Turner 1975; Niblack 1890 |
| *F. pudica* (Pursh) Spreng. (yellowbells) | bulbs | Lillooet, Nez Perce, and other interior peoples | Bouchard and Kennedy 1977; Marshall 1977; Turner 1978; Hunn 1990 |
| *Glaux maritima* L. (sea milkwort) | roots | Kwakwaka'wakw | Boas 1921; Turner 1975 |

TABLE 1.—Traditional plant foods of northwestern North America, used regularly, but particularly valuable or useful as survival foods in winter and/or early spring. (continued)

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *Lewisia rediviva* Pursh (bitterroot) | taproots | Interior Plateau peoples | Turner 1978; Hunn 1990; Turner et al. 1990 |
| *Lilium columbianum* Hanson (tigerlily, Columbia lily) | bulbs | Lillooet, Nlaka'pamux, and other peoples, both coastal and interior | Turner 1975, 1978; Turner et al. 1990 |
| *Lomatium canbyi* Coult. & Rose (Canby's lomatium) | tuberous roots | Nez Perce; Nlaka'pamux, and other Interior Plateau peoples | Marshall 1977; Hunn 1990; Turner et al. 1990 |
| *L. cous* (Wats.) Coult. & Rose (cous, biscuitroot) | tuberous roots | Interior Plateau peoples | Turner 1978; Hunn 1990; Turner et al. 1990 |
| *L. grayi* Coult. & Rose (Gray's lomatium) | tuberous roots | Sahaptin and other southern Plateau peoples | Hunn 1990 |
| *L. macrocarpum* (Nutt.) Coult. & Rose (desert parsley) | taproots | Interior Plateau peoples | Turner 1978; Hunn 1990; Turner et al. 1990 |
| *Lomatium* spp. (biscuitroots, other species) | thickened roots | various parts of the Plateau region | Hunn and French 1981; Hunn 1990 |
| *Lupinus nootkatensis* Donn ex Sims (Nootka lupine) | roots (possibly toxic) | Kwakwaka'wakw, Nuxalk, and other coastal peoples | Boas 1921; Turner 1975 |
| *L. littoralis* Dougl. ex Lindl. (seashore lupine) | roots (possibly toxic) | Haida, Kathlamet, and possibly other coastal peoples | Turner 1975 |
| *Perideridia gairdneri* (H & A.) Mathias (Yampah, "Indian carrot") | tuberous roots | coastal (?) and southern interior peoples | Turner 1975, 1978; Hunn 1990 |
| *Potentilla anserina* L. ssp. *pacifica* (L.) Howell and ssp. *anserina* (silverweed) | thickened roots | coastal and interior peoples, general | Turner and Kuhnlein 1982; Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Pteridium aquilinum* (L.) Kuhn. (Bracken fern) | rhizomes | coastal and interior peoples, general | Turner 1975, 1978; Norton 1979; Turner et al. 1990 |
| *Tauschia hooveri* Math. & Const. (tauschia) | tuberous roots | Sahaptin and other southern Plateau peoples | Hunn 1990 |

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *Typha latifolia* L. (cattail) | rhizomes | Lillooet, Nlaka'pamux, Kathlamet, and other peoples | Boas 1901; Bouchard and Kennedy 1977; Turner et al. 1990 |
| **Fruits (available in winter and/or spring)** | | | |
| *Arctostaphylos uva-ursi* (L.) Spreng. (kinnikinnick) | berries | coastal and interior peoples, general | Carrier Linguistic Committee, 1973; 'Ksan, People of 1980; Kuhnlein and Turner 1991 |
| *Balsamorhiza sagittata* (balsamroot, spring sunflower) | seed meal, as porridge | Flathead, Okanagan, and other southern Plateau peoples | Hart 1976; Turner et al. 1980 |
| *Empetrum nigrum* L. (crowberry) | berries | northern peoples, general | Kuhnlein and Turner 1991 |
| *Viburnum edule* Raf. (highbush cranberry) | berries | Carrier, interior people general | S. Birchwater, Anahim Lake, personal communication to NJT, 1991 |

during the winter and early spring, although two of the latter (*Arctostaphylos uva-ursi* and *Empetrum nigrum*) were in some areas less preferred fruits (see Table 2).

Spiney wood fern *(Dryopteris expansa)* is a good example of a "root" vegetable (Turner et al. 1992.). The rootstocks, which were dug and eaten in quantity from fall through spring, were also known in many areas as a good survival or starvation food. Tanaina consultants compared them favorably with clams as a survival food (Kari 1987); Gitksan people with hemlock cambium *(Tsuga heterophylla)* (Jeff Harris Sr., cited in Turner et al. 1992). The 'Ksan (Gitksan) people note that this fern ". . . has warded off starvation more than once." ('Ksan, People of 1980:79).

Some of the root vegetables were also used as staples in various areas, but might be specially sought when other, less predictable food sources failed or were unavailable for one reason or another. *Lilium columbianum* roots, for example, were normally used in small quantities as a condiment, but one Lillooet woman fed her family almost exclusively on these roots, cooked as soup, when she had no other food available (Margaret Lester, Mount Currie Band, personal communication, 1984). A similar situation has occurred in other areas. For example, among the Fisherman Lake Slave, the root vegetable *Hedysarum alpinum* L. was used as a winter starvation food as well as staple (Lamont 1977).

*Alternative or less preferred plant foods.*—In northwestern North America, a variety of traditional foods fit into the category of "less preferred." Among animal foods, fish-heads, storm-killed small fish, mussels and other shell-fish (Nuu-chah-nulth, Nlaka'pamux), small birds such as robins (Nlakapa'mux, Koyokon), and small predatory mammals, including dogs (Secwepemc), martins, and wolverines

TABLE 2.—Alternative plant foods: those eaten to some extent during normal circumstances, but having a minimal contribution under a normal dietary regime.

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Inner Bark (see also TABLE 1; some species less preferred by some groups)** | | | |
| *Abies grandis* (Dougl. ex D. Don) Lindl. (grand fir) | inner bark; cambium | Nlaka'pamux and some other groups | Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Picea mariana* (Mill.) B.S.P. (black spruce) | inner bark; cambium | Tanaina | Kari 1987 |
| *Pseudotsuga menziesii* (Mirb.) Franco (Douglas-fir) | inner bark; cambium | Carrier and some other groups | B. Compton, personal communication to NJT, 1992 |
| **Lichens and Algae** | | | |
| *Bryoria fremontii* (black tree lichen) | whole thallus | some interior groups | Kuhnlein and Turner 1991; see text |
| **Green Vegetables** | | | |
| *Epilobium angustifolium* (fireweed) | shoots; occasionally mature stalks | Haisla and some other groups, not preferred | Turner 1978; Teit 1909; Louise Barbetti, personal communication to AD, 1992) |
| *Opuntia* spp. (prickly-pear cacti) | fleshy stems | Blackfoot | Kuhnlein and Turner 1991 |
| **"Root" Vegetables** | | | |
| *Balsamorhiza incana* Nutt. (balsamroot) | taproot | Nez Perce | Marshall 1977 |
| *Glaux maritima* (sea milkwort) | roots (raw) | Kwakwaka'wakw, Sechelt, and Comox | Boas 1921; Kennedy and Bouchard 1983 |
| *Lomatium gormanii* (Howell.) Coult. & Rose (Gorman's lomatium) | tuberous roots (*L. canbyi* roots preferred) | Nez Perce | Marshall 1977 |
| *L. salmoniflorum* (salmon lomatium) | tuberous roots | Nez Perce | Marshall 1977 |
| *Lysichitum americanum* Hult. & St. John (skunk-cabbage) | rhizomes (possibly toxic) | Lower Lillooet; Kathlamet | Boas 1901; Bouchard and Kennedy 1977 |
| *Polystichum munitum* (Kaulf.) K.B. Presl (sword fern) | rootstocks | coastal peoples, general | Turner et al. 1992 |

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Fruits** | | | |
| *Arctostaphylos uva-ursi* (kinnikinnick) | berries | Lillooet and others | Kuhnlein and Turner 1991; Heller 1976 |
| *Berberis aquifolium* (Pursh) Nutt. (tall Oregon-grape) | berries | general | Turner et al. 1990; Kuhnlein and Turner 1991 |
| *B. nervosa* (Pursh) Nutt. (common Oregon-grape) | berries | coastal peoples, general | Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Comandra umbellata* (L.) Nutt. (bastard toadflax) | berries | Lillooet | Kuhnlein and Turner 1991 |
| *Cornus stolonifera* Michx. (syn. *C. sericea* L.) (red-osier dogwood; "red willow") | berries | interior peoples, general | Turner et al. 1990; Kuhnlein and Turner 1991 |
| *Crataegus douglasii* Lindl. (black hawthorn) | berries | coastal and interior peoples, general | Turner 1992; Turner et al. 1980 |
| *C. columbiana* Howell (red hawthorn) | berries | interior peoples, general | Turner et al. 1980; Kuhnlein and Turner 1991 |
| *Disporum hookeri* (Torr.) Nicholson (Hooker's fairybells) | berries | Nlaka'pamux and others | Turner et al. 1990 |
| *Maianthemum dilatatum* (Wood) Nels. & Macbr. (wild lily-of-the-valley) | berries | coastal peoples, general | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *Oemleria cerasiformis* (H. & A.) Land (Indian-plum; bird cherry) | drupes | south coastal peoples, general | Gunther, 1973; Turner 1975; Turner et al. 1990 |
| *Quercus garryana* Dougl. ex Hook. (garry oak) | acorns | south coastal peoples, general | Gunther 1973; Kuhnlein and Turner 1991 |
| *Ribes aureum* Pursh (golden currant) | berries | Nez Perce | Marshall 1977 |
| *R. cereum* Dougl. (squaw currant) | berries | Interior Plateau peoples, general | Turner 1978; Turner et al. 1990 |
| *R. hudsonianum* Richards. (northern black currant) | berries | interior peoples, general | Turner 1978; Turner et al. 1990 |
| *R. laxiflorum* Pursh (trailing currant) | berries | coastal peoples, general | Turner 1975 |

TABLE 2.—Alternative plant foods: those eaten to some extent during normal circumstances, but having a minimal contribution under a normal dietary regime. (continued)

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *R. viscosissimum* Pursh (sticky currant) | berries | Interior Plateau peoples, general | Turner 1978; Turner et al. 1990 |
| *Rosa acicularis* Lindl (prickly wild rose) | hips | Western Washington and interior peoples, general | Gunther 1973; Hart 1976; Turner et al. 1980; Turner et al. 1990 |
| *R. nutkana* Presl. (Nootka wild rose) | hips | coastal and interior peoples, general | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *R. gymnocarpa* Nutt. (dwarf, or baldhip rose) | hips | Nlaka'pamux and other peoples | Teit 1909 |
| *R. woodsii* Lindl. (Wood's wild rose) | hips | Nez Perce and other interior peoples | Marshall 1977 |
| *Rubus pedatus* J. E. Smith (trailing raspberry) | druplets | coastal and interior peoples, general | Turner 1975, 1978; Norton 1981; Turner et al. 1990 |
| *Sambucus cerulea* Raf. (blue elderberry) | berries | Nlaka'pamux and other interior peoples | Turner et al. 1990 |
| *S. racemosa* L. (red elderberry) | berries | Straits, and other coastal peoples, general | Turner 1975, 1978; Kuhnlein and Turner 1991 |
| *Shepherdia canadensis* (L.) Nutt. (soapberry, soopolallie) | berries | Blackfoot, and some other interior peoples | Johnston 1987 |
| *Smilacina racemosa* (L.) Desf. (false Solomon's-seal) | berries | Nlaka'pamux and other interior peoples | Turner 1978; Turner et al. 1990 |
| *S. stellata* (L.) Desf. (star-flowered Solomon's-seal) | berries | Nlaka'pamux and some other interior peoples | Turner 1978; Turner et al. 1990 |
| *Sorbus sitchensis* Roemer (Sitka mountain-ash) | berries | coastal and interior peoples, general | Turner 1978; Turner et al. 1990 |
| *S. scopulina* Greene (western mountain-ash) | berries | interior peoples, general | Turner 1978; Turner et al. 1990 |

(Koyokon) fit into this category, all being ". . . disdained in normal times" (Drucker 1951:36–37; see also Teit 1909; Laforet et al. 1994; Nelson 1983).

Table 2 provides an inventory of traditional plant foods of the secondary, less preferred type that became prominent when regular, preferred foods were un-

available. A total of 40 species are included, the majority (28) of which are fruits, together with about six less preferred root foods. An example of food in this category is rosehips (*Rosa nutkana* and *R. woodsii*) used by the Nez Perce, as well as by other groups. Marshall (1977) notes that these were not a favored food of the Nez Perce, and were collected only as a supplement to the regular diet, except in years where other fruits were in short supply. Then they would be gathered and dried in quantity for winter use. Another example is black hawthorn *(Crataegus douglasii)* among the Gitksan: "The fruit is dry and mealy and was eaten only if nothing else was available . . ." ('Ksan, People of 1980:72; see also Turner 1992 for Lillooet and Turner et al. 1980 for Okanagan).

As mentioned, some of the foods listed in Table 2 vary from one region to another in the preference people have for them. For example, soapberry *(Shepherdia canadensis)* was eaten only "in lean times" by the Blackfoot (Kuhnlein and Turner 1991), but the berries were, and still are, widely consumed as a whipped confection and as a beverage base by Aboriginal Peoples in British Columbia. Kinnikinnick *(Arctostaphylos uva-ursi)* berries are another rood well liked in some areas, and eaten only in necessity in others (Turner 1975, 1978).

Seasonal variation in berry productivity was often a cause for resorting to secondary fruits (Laforet et al. 1994 for Nlaka'pamux). Seasonal variation in "ripening" of root vegetables as noted by Marshall (1977) among the Nez Perce (for *Lomatium canbyi,* with maturation dates ranging from mid-March to mid-May depending upon the year), could also result in the need to search for alternative foods.

*True famine foods.*—Some "foods" were never eaten except in times of extreme hunger. There are many examples of such plant materials from central, northern, and eastern North America (Parker 1910; Aller 1954; Jones 1965; Eidlitz 1969; Lamont 1977; Marles 1984; Leighton 1985). Many of these famine foods are bitter and unpalatable, and some are toxic (Lamont 1977; Kuhnlein and Turner 1991).

There are a few examples of such foods from northwestern North America. These are listed in Table 3. Some of these, such as black tree lichen *(Bryoria fremontii)* and Nootka lupine roots *(Lupinus nootkatensis),* were used more generally as well, but as emergency or famine foods they were eaten raw. *Bryoria* contains bitter lichen acids, and, in its raw state, indigestible complex lichen carbohydrates that could cause discomfort and pain in the digestive tract. Lupines contain a number of potent alkaloids, including lupinine, lupanine, anagyrine, and sparteine, which act on the nervous system. Some also contain enzyme inhibitors and other toxins. These cause symptoms ranging from headaches to nausea and dizziness (Turner and Szczawinski 1991). Yet, in desperation, people turned to such foods.

*Hunger suppressants and thirst quenchers.*—Plant foods in this category are diverse and ecclectic (Table 4). They include products that could be considered simply as casual or occasional foods, but because some of them are specifically reported to serve as hunger suppressants, thirst quenchers, or sources of liquid in emergencies, they are included here, even though their actual survival value might be minimal. These "foods" were usually consumed by people travelling—hunters,

TABLE 3.—True famine foods: those never eaten except in times of extreme hunger.

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Bark and Inner Bark** | | | |
| (see TABLES 1 & 2; in some areas inner barks were eaten only in extreme emergencies) | | | |
| **Lichens and Algae** | | | |
| *Bryoria fremontii* (Black tree lichen) | raw thallus | Secwepemc | Mary Thomas, Salmon Arm, B.C., personal communication to NT, 1991 |
| **"Root" Vegetables** | | | |
| *Blechnum spicant* (L.) Roth. (deer fern) | rootstock | western Washington peoples | Gunther 1973 |
| *Lomatium dissectum* (chocolate tips) | taproots "starvation food" | Nez Perce | Marshall 1977 |
| *Lupinus nootkatensis* (Nootka lupine) | raw roots (potentially toxic) | Kwakwaka'wakw | Boas 1921; Turner and Bell 1973; Turner 1975 |
| *Lysichitum americanum* (skunk-cabbage) | rhizomes (potentially toxic) | Quileute, Kathlamet | Boas 1901; Gunther 1973 |
| **Fruits** | | | |
| *Elaeagnus commutata* Bernh. ex Rydb. (silverberry) | berries | Blackfoot, Stoney, and others | Johnston 1987; Kuhnlein and Turner 1991) |

berry pickers, or those lost in the woods—for temporary hunger or thirst suppression. A typical example is licorice fern rhizome *(Polypodium glycyrrhiza),* used as reported by Boas (1921:526): "When a hunter goes hunting, he holds a fern-root in his mouth in order not to get hungry and thirsty. . . ."

## DISCUSSION

*Importance of famine foods to survival.*—The cultural and dietary significance of famine foods should not be underestimated (Turner 1988; Minnis 1991). Although many were used casually and some very infrequently, their contribution to survival of individuals, and even entire communities, was critical. This is illustrated by the following quotations from Nlaka'pamux (Thompson) elder Annie York, recollecting stories of famine told to her by her great aunt, Josephine George of the Nicola Valley (Turner et al. 1990:32):

TABLE 4.—Hunger suppressants and thirst quenchers[1]

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| **Inner Bark (see also Table 2)** | | | |
| *Pyrus fusca* Raf. (Pacific crabapple) | bark (chewed as thirst suppressant) | Oweekeno | B. Compton, personal communication to NT, 1992 |
| **Lichens and Algae** | | | |
| *Bryoria fremontii* (black tree lichen) | raw thallus (chewed as thirst quencher) | Secwepemc | Mary Thomas, elder, Salmon Arm, personal communication to NT, 1991 |
| **Greens** | | | |
| *Arbutus menziesii* Pursh (arbutus, Pacific madrone) | leaves (chewed for endurance) | Halkomelem | Turner et al. 1990 |
| *Arctostaphylos uva-ursi* (kinnikinnick) | leaves (chewed as thirst quencher) | Nlaka'pamux | Turner et al. 1990 |
| *Blechnum spicant* (L.) Roth. (deer fern) | fronds (hunger suppressant) | Ditidaht | Turner et al. 1983 |
| *Balsamorhiza sagittata* (balsamroot, spring sunflower) | young shoots, greens (hunger suppressant) | Nlaka'pamux | Turner et al. 1990 |
| *Gaultheria shallon* Pursh (salal) | young leaves (hunger suppressant) | Ditidaht | Turner et al. 1983 |
| *Lomatium salmoniflorum* (salmon lomatium) | leaves (chewed) | Nez Perce | Marshall 1977 |
| *Picea sitchensis* (Sitka spruce) | shoot tips (chewed) | Makah | Gunther 1973 |
| *Pinus contorta* (lodgepole pine) | shoot tips (chewed) | Nlaka'pamux | Turner et al. 1990 |
| *Pseudotsuga menziesii* (Douglas-fir) | shoot tips (chewed) | Nlaka'pamux | Turner et al. 1990 |
| *Tsuga heterophylla* (western hemlock) | young shoots (hunger suppressant) | Ditidaht | Turner et al. 1983 |
| **"Roots"** | | | |
| *Polypodium glycyrrhiza* (L.) DC. (licorice fern) | rhizomes (hunger, thirst suppressant) | Kwakwaka'wakw and other coastal peoples | Boas 1921; Kuhnlein and Turner 1991 |
| *Erythronium revolutum* (pink Easter-lily) | raw bulbs (thirst quencher) | Kwakwaka'wakw | Boas 1921 |

TABLE 4.—Hunger suppressants and thirst quenchers[1] (continued)

| Plant (common name) | Part Consumed | Cultural Group | Reference |
|---|---|---|---|
| *Trifolium wormskioldii* Lehm. (springbank clover) | raw rhizomes | Kwakwaka'wakw | Boas 1921 |
| **Fruits** | | | |
| *Cornus stolonifera* Michx. (red-osier dogwood) | berries (chewed as thirst quencher) | Secwepemc | Mary Thomas, personal communication to NT, 1992 |
| *Juniperus scopulorum* Sarg. (Rocky Mountain juniper) | "berries" (chewed as hunger suppressant) | Lillooet and possibly other groups | Kuhnlein and Turner 1991 |
| *Vaccinium oxycoccus* L. (bog cranberry) | berries (chewed as thirst quencher) | Tanaina | Kari 1987 |
| *Viburnum edule* (highbush-cranberry) | frozen berries (hunger suppressant) | Carrier and others of central British Columbia | S. Birchwater, personal communication to NT, 1991; Carrier Linguistic Committee 1973 |

[1]In addition to the above, the fluid in the hollow stem segments of *Equisetum telmateia* (giant horsetail) and *E. hiemale* L. (scouring rush) were regarded as safe for drinking in areas where the water might be contaminated by the Ditidaht, Gitksan *(E. hiemale)*, and possibly other peoples ('Ksan, People of 1980; Turner et al. 1983).

Gum from the following trees was also chewed for pleasure, and possibly to suppress hunger: *Abies amabilis* (Dougl.) Forbes (amabilis fir; used by Ditidaht); *Larix occidentalis* Nutt. (western larch; used by Interior Salish); *Picea sitchensis* (Sitka spruce; Ditidaht and other coastal peoples); *P. glauca, P. engelmannii, P. mariana* (white spruce, Engelmann spruce; black spruce; Chilcotin, Carrier and other interior peoples); *Pinus contorta* (lodgepole pine—Nlaka'pamux and others); *P. monticola* Dougl. (white pine; Nlaka'pamux); *Pseudotsuga menziesii* (Douglas-fir; Nlaka'pamux and others) (cf. Carrier Linguistic Committee 1973; Turner et al. 1983; Turner et al. 1990; Kuhnlein and Turner 1991).

Teas were made from a number of plant products, and at some times, these may have been used to alleviate hunger or provide nutrients. "Tea plants" include: *Abies grandis* (grand fir; Nlaka'pamux and others); *A. lasiocarpa* (subalpine fir; Nlaka'pamux and others); *Pinus contorta* (lodgepole pine; Nlaka'pamux and others); *Pseudotsuga menziesii* (Douglas-fir; Nlaka'pamux and others); *Betula glandulosa* Michx. (scrub birch; Chilcotin); *Ledum groenlandicum* Oeder (Labrador-tea; widely used throughout region); *L. glandulosum* Nutt. (trapper's-tea; used by Interior Salish and Chilcotin); *Satureja douglasii* (Benth.) Briq. (*Yerba buena;* Straits Salish of southern Vancouver Island); *Mentha arvensis* L. (field mint; widely used); *Monarda fistulosa* L. (wild bergamot; purple beebalm; Secwepemc (Shuswap) and Kootenay).

> But one time, that year was the famine. They had nothing, no fish, everything was scarce . . . So they went up Broadback [Mountain] . . . to try to get up to where this ***sk'ámə̀c*** [avalanche lily, *Erythronium grandiflorum*] may be . . . they went up there in the spring. . . . And the people that eats ***hákʷu?*** [cow-parsnip, *Heracleum lanatum*] . . . was the ones that

> survived . . . They're very valuable food, when Indians had that ***hákʷu?*** . . . . and ***tətúwʔ*** [spring beauty, *Claytonia lanceolata*] . . . what they could dig out . . . survived. But the ones that didn't eat them, they're just trying to get a deer or something, then they died. [Those that ate] cow-parsnip and spring beauty, avalanche lily, tiger lily [*Lilium columbianum*] . . . and Indian carrot [*Lomatium macrocarpum*], and thistle [*Cirsium undulatum*] . . . so they eat that and they survive.
>
> They survived on that, too, the ***sáʔeq*** root [bracken fern rhizomes, *Pteridium aquilinum*] . . . They go out and get that in the winter time . . . then take it and hit the bark off, and it's just the white in there, and you chew it. . . .
>
> The ***skéz'kəz'*** [prickly-pear cactus, *Opuntia fragilis* and *O. polyacantha*] they always eat it all right enough, but they had to eat it [during a famine]; my grandaunt told me, 'We eat that three times a day!' she says. There was no fish, nothing. And that [cactus] was all the children, even to the babies, had to eat . . . after they steam it. That was in springtime. . . .

Similarly, among the Haida, Niblack (1890:276–277) notes:

> Some of these berries are collected and dried for winter's use, forming, with dried fish, the principal winter's supply . . . they [Haida] often . . . eat up all the dried berries before spring, and were it not for a few bulbs [apparently *Fritillaria camschatcensis*] which they dig out of the soil in the early springtime, while awaiting the halibut-season, numbers of Indians really would starve to death.

Other foods such as black hawthorn berries *(Crataegus douglasii)* and spiney wood fern rootstocks *(Dryopteris expansa),* which might have been used casually in a mixed diet, or completely spurned in normal circumstances, took on far greater importance in lean times.

Of the various foods listed in Tables 1–4, only the "root" vegetables, and to a lesser extent the fruits, could have contributed substantially to the caloric content of peoples' diets. Cattail rhizomes *(Typha latifolia),* for example, contain 7.7 g protein and 79.1 g carbohydrate per 100 g fresh weight, and licorice fern *(Polypodium glycyrrhiza)* contains 24 grams carbohydrate, or 138 kcal. food energy per 100 g fresh weight (Kuhnlein and Turner 1991). However, in times of food shortage and famine, other nutrients might also have been limited. Hunn (1990:108) notes the potential importance of an early spring green vegetable in providing Vitamin C: "The key nutrient in these sprouts [*Lomatium nudicaule*] and stalks is Vitamin C. . . . Vitamin C may have been a nutrient in short supply in late winter for plateau peoples who had subsisted for several months on a diet of dried foods." Greens, roots, inner bark, casual foods such as those listed in Table 4, and even beverage and medicinal teas may have served as sources of such critical nutrients. Tables 5 and 6 provide levels of Vitamin A, Vitamin C, and B vitamins (thiamine, niacin, and riboflavin) in some of the springtime vegetables used by Indigenous People of northwestern North America (after Kuhnlein and Turner 1991).

The toxic qualities of famine foods need further investigation. Johns (1990)

TABLE 5.—Selected nutritional constituents for some indigenous early spring root vegetables of northwestern North America (after Kuhnlein and Turner 1991).

| Species/food | Thiamine mg* | Riboflav. mg* | Niacin mg* | Vit. C mg* | Vit. A RE* |
|---|---|---|---|---|---|
| Common camas/bulbs (*Camassia quamash*) | 0.07 | 0.05 | — | 4.0 | — |
| Spiney wood fern/roots (*Dryopteris expansa*) (steamed) | 0.06 | 0.04 | 0.6 | — | 0.3 |
| Riceroot (*Fritillaria lanceolata*) | 0.04 | 0.04 | 0.2 | 29.0 | 0 |
| Bitterroot/roots (*Lewisia rediviva*) (fresh) | 0.10 | 0.02 | — | 27.0 | — |
| Silverweed/roots (*Potentilla pacifica*) (steamed) | 0.01 | 0.01 | 2.4 | — | 0.2 |
| Clover/roots (*Trifolium wormskioldii*) (steamed) | 0.06 | 0.04 | 0.6 | — | 0.3 |

*per 100 g fresh weight; RE = retinol equivalent of ß-carotene

and Johns and Kubo (1988) provide a general discussion of strategies employed by people for detoxifying potentially harmful foods. In times of hunger, people may have had to resort to less edible products, and due to energy considerations, may have forgone the usual detoxifying preparation techniques. For example, cooking apparently expells some of the toxic alkaloids in lupine roots (*Lupinus nootkatensis, L. littoralis*). Eating these roots raw, as was apparently done in times of famine, would have exposed people to higher levels of toxins. Skunk-cabbage (*Lysichitum americanum*) rhizomes are also known to be toxic in their raw state, due to the presence of calcium oxalate crystals (Turner and Szczawinski 1991). Even when cooked, they were said to be "hot" and "peppery" (Bouchard and Kennedy 1977). Raw black tree lichen (*Bryoria fremontii*) and yellow avalanche lily corms (*Erythronium grandiflorum*) would certainly have been less digestible than the cooked versions (Kuhnlein and Turner 1991).

Other potentially toxic foods that may have caused poisoning under some circumstances if used excessively include red elderberries (*Sambucus racemosa*) which contain cyanogenic glycosides. They have a reputation for causing nausea when eaten raw, and Boas (1921:594) notes, "They never drink water after eating them," and further, that they will cause nausea if eaten in the morning (Turner and Szczawinski 1991). The springtime green vegetable, arrow-grass (*Triglochin maritimum*), also contains cyanogenic glycosides, as does bracken fern (*Pteridium aquilinum*) and the seeds of various fruits of the rose family, including wild cherries (*Prunus* spp.), hawthorns (*Crataegus* spp.), and mountain-ash (*Sorbus* spp.). Black hawthorn (*C. douglasii*) fruits have a reputation for causing stomach ache and constipation if eaten excessively, and may have compromised people's survival when used in quantity as a famine food. However, if as was likely, the seeds were swallowed intact, they would not have been particularly toxic.

TABLE 6.—Selected nutritional constituents for some indigenous early spring green vegetables of northwestern North America (After Kuhnlein and Turner 1991).

| Species/food | Thiamine mg* | Riboflav. mg* | Niacin mg* | Vit. C mg* | Vit. A RE* |
|---|---|---|---|---|---|
| Balsamroot/greens (*Balsamorhiza sagittata*) | — | — | — | 13.8 | — |
| Fireweed/leaves (*Epilobium angustifolium*) | — | — | — | 88.0 | 22 |
| Horsetail/greens (*Equisetum arvense*) | 0 | 0.07 | 5.6 | 50.0 | 18 |
| Cow-Parsnip/peeled stalks (*Heracleum lanatum*) | 0 | 0.12 | 0.3 | 3.5 | 7.5 |
| Labrador-tea/leaves (*Ledum groenlandicum*) | 0.01 | 0.40 | 92.0 | 98.2 | — |
| Indian celery/greens (*Lomatium nudicaule*) | 0.02 | 0.08 | — | 66.0 | — |
| Red laver seaweed (*Porphyra* sp.) | 0.37 | 1.79 | 6.7 | 11.6 | 263 |
| Thimbleberry, peeled shoots (*Rubus parviflorus*) | 0.01 | 0.09 | 0.3 | 5.9 | 41 |
| Eastern hemlock (*Tsuga canadensis*) | — | — | — | 238 | — |

*per 100g fresh weight; RE = retinol equivalent of ß-carotene

*Cultural elements of food shortage.*—To what extent were food shortages caused by overharvesting or other human impacts on traditional food resources? There is some evidence that local shortages occurred from excessive harvesting. For example, among the Sahaptin, in spring, "The women climbed to the ridges above to dig bitterroot and Lomatiums . . . when the local supplies were exhausted . . . the people moved camp further upstream to the next tributary canyon." (Hunn 1990:123). Archaeologist Brian Hayden (personal communication to NT, 1985) believes that general overharvesting and subsequent depletion of root vegetables in the Lillooet area may have resulted in prehistoric population declines in areas such as the large village site at Keatley Creek.

The role of advances in technology and their effect on intensification of resource harvesting, increasing population, and possible subsequent resource depletion needs to be examined. For example, pit-cooking as a technique seems to have developed as a major method of root vegetable processing in the northern Plateau area within the last 3000–4000 years (Pokotylo and Froese 1983). What effect did this technique have on exploitation of root vegetables, and on human populations and resource plant populations in the region? To date, however, there is little concrete evidence to indicate widespread plant resource depletion in any region, except perhaps within modern times. Within the last century, landscape burning, said to enhance plant food production, has been suppressed by Forest Service policies, and this has caused a depletion in quantity and quality of some plant foods (Turner 1991). Other recent problems include overgrazing of live-stock, pesticide use, and introduction of aggressive, weedy species, all of which

have been said to have caused a deterioration in traditional plant foods (Turner 1991, 1992; Mary Thomas, Secwepemc elder, personal communication to NT, 1991). It has been noted in diverse regions that the traditional selective harvesting of roots, greens, and berries, and the accompanying cultivation of the soil, "pruning" of berry branches, and burning of harvesting grounds have resulted in long-term sustainability of harvest areas (Marshall 1977; Turner 1991; Martinez 1992).

Another cultural aspect of food scarcity is noted by Minnis (1991), namely, that preference for particular foods may shift over time and under changing circumstances. In Arizona and New Mexico among traditional Indigenous Peoples, foods that are now considered "famine foods" were staples prehistorically; domination by European and North American states since Spanish contact has resulted in this change. Kuhnlein (1989, 1992) also notes changing dietary preferences in an Indigenous community of coastal British Columbia (Nuxalk). Thus, it is important that alternative food sources, and famine foods, be considered within their temporal and cultural context.

There are, naturally, many cultural factors relating to limitations in food supply in northwestern North America. Migration, social alliances, warfare, trade, communal strategies for food distribution and sharing, ritual and ceremonial practices relating to harvesting and renewal, and social discourse are some of the elements directly relating to food scarcity.

The "seasonal round" of all northwestern Aboriginal Peoples was a strategy enabling people to harvest the variety of foods and other resources they required for survival from different localities and habitats. Unlike agrarian societies, where people were relatively sedentary, focusing a major portion of their energies on food production in one area, hunter-fisher-gatherer peoples used a wider diversity of foods from a wider area, and hence mitigated the possibility of food scarcity by being less reliant on any one type of food (Brown 1985). When local scarcity did occur, people sometimes migrated to other areas. For example, Nlaka'pamux elder Annie York (personal communication to NT, 1985) was told about a time when there was no food to be had in the Fraser Canyon and Nicola Valley areas, and people travelled east to Douglas Lake in search of game and vegetable foods. She also mentioned (as quoted earlier) that people travelled to upland areas to get roots in early spring when other foods were not available.

There were other strategies for obtaining food. Food products from one region were routinely traded with those of another, and there were also affinal exchanges, potlatches, and other formal exchange media (Suttles 1987, 1990; Turner 1975, 1978; Turner et al. 1990).

Hunn (1981) has stressed the critical contribution of women in food production in the Columbia Plateau region. His points are emphasized by the particular importance of plant foods in times of scarcity, because of their greater reliability than animal foods. Furthermore, women contributed significantly to food acquisition through their basketry and other skills. Some of the Spuzzum Nlaka'pamux women, for example, were able to exchange their finely crafted coiled baskets of split cedar root for plant foods from the Upper Thompson area, including silverweed, bitterroot, dried saskatoon berries, and soapberries (Turner et al. 1990). Basketry products were also traded for food by the Lillooet and other peoples, right up until the present time (Margaret Lester, Mount Currie Band, personal

communication to NT, 1985). Clarkson et al. (1993) also stress the critical role of Indigenous women in preserving aspects of cultural knowledge such as the details of famine food use.

Perhaps another indication of the recognition of plant foods as constant and more reliable than animal foods is that, at least among the Nlaka'pamux (Thompson), despite a host of taboos against eating certain foods at certain ritually vulnerable times of people's lives, there were very few ritual restrictions on consumption of vegetable foods; most of the restrictions pertained to animal food products (Laforet et al. 1994).

Warfare also resulted in, and presumably alleviated, food shortages, as indicated by the following notation on the Sechelt people: "[The Sechelt] . . . did not store their winter supplies in their dwellings, but 'cached' them in the woods. Only a few days' supply was ever carried home. This peculiar custom was due to the marauding proclivities of the neighbouring ***YukEltas*** [***Euclataw***—a Kwakwaka'wakw group from Vancouver Island], who made periodical forays upon their settlement and carried off all they could lay hands upon. It was unsafe, therefore, to keep a large store of food by them" (Hill Tout n.d.:29–30). Drucker (1951:36–37) also notes the relationship between food shortages and intergroup conflict among the Nuu-chah-nulth: "Family traditions of local groups . . . speak of hunger and even starvation that led them to make alliances with or make war on groups who had territories along the inner channels and owned salmon streams." Dewhirst (1978:21) examines the role of resource scarcity in Nootka Sound, suggesting that the whale hunting technologies of the outside groups may have developed in response to "a tight fit between population growth with increased local groups and ownership of limited resource properties."

Within communities and extended families, food sharing was generally practiced (Kennedy and Bouchard 1983 for Sliammon), and food distribution was formalized in such ceremonies as the First Roots and First Shoots ceremonies of the Okanagan-Colville, Sahaptin, and others (Hart 1976; Turner et al. 1980; Hunn 1990). By their very nature, these ceremonies focused on some of the critical springtime plant foods listed in Table 1, including *Lomatium geyeri, Lewisia rediviva,* and *Claytonia lanceolata.*

Among the Sahaptin, Hunn notes that visiting also served as a means of redistributing food surpluses and compensating for local shortages, as "visiting has always been an occasion for feasting . . ." (Hunn 1990:121). Glutiny or selfishness regarding food use was considered shameful, however, as illustrated in the earlier mentioned Lillooet story of "The Abandoned Boy," where the son of a chief was abandoned by his father and all the villagers because he had been secretly begging food from people in the village (Bouchard and Kennedy 1977:30–31; Hill Tout n.d.:201–204).

There were other limitations to communal sharing of food, at least in some societies. Among the Chinook, for example, Ray's principal consultant declared that the upper class could infringe as much as it pleased upon the lower classes and added that famine was unknown to the former since the food of the latter was appropriated in such a circumstance (Ray 1938:56).

Some food resources and harvesting areas were "owned" by individuals, especially within some Northwest Coast groups (Turner 1975; Turner and Kuhn-

lein 1983; Turner et al. 1983). Ownership carried with it obligations, however. A person who "owned" productive patches of silverweed and springbank clover was expected to share these food resources with his village, and, in some cases, to host feasts for particular groups or societies within the community. For example, Boas (1921:560) reports that among the Kwakwaka'wakw (Southern Kwakiutl), "When the people have a winter dance, the owner of lily-bulbs [*Fritillaria camschatcensis*] promises a lily-bulb-feast to the Sparrow Society. . . ."

As well as their direct nutritional value, plants also served in other ways to aid in survival. For example, the roots of chocolate-tips *(Lomatium dissectum)* were used as a fish poison for Interior Plateau peoples, mostly for small fish species of upland creeks (Turner et al. 1980; Meilleur et al. 1990). This use probably helped people to sustain themselves at times when salmon and other foods were not available. One Lillooet woman noted that her family had used stored bags of raw black tree lichen *(Bryoria fremontii)* to chink the cracks in their log cabin during a particularly cold winter (Turner et al. 1987, Lillooet).

Minnis (1991) notes the significant role of myth and ritual in indigenous societies as particularly important vehicles for transmitting the knowledge of famine food use between generations, stressing that this category of ethnobotanical knowledge is easily lost. There are many records in the myths and traditions of northwestern American Indigenous Peoples relating to times of hunger and famine. One example is the Kathlamet (Lower Chinook) story about skunk-cabbage *(Lysichitum americanum)*, quoted in the introduction (Boas 1901:50). Another example is a Haida myth alluding to people using sword fern root *(Polystichum munitum)* as an emergency food; this caused Fern-Woman, the mythical personification of Sword Fern, to cry (Swanton 1905).

Evidence points to the occurrence of major food shortages back into prehistoric times. Even within the historic period, however, food shortages were known to occur among Aboriginal Peoples. Food shortages were also experienced by European explorers, naturalists, and settlers, many of whom were able to survive only by learning about famine foods from the local Indigenous Peoples. Outside of the study area, perhaps the most famous incidence of starvation incurred by explorers was during the Richardson and Franklin expeditions, where desperate men chewed on rock tripe lichens (*Gyrophora* spp.), which caused severe gastrointestinal pains, but sustained them in critical periods (Houston 1984). In northwestern North America, Meriwether Lewis and William Clark owed their survival to the roots and black tree lichen provided by Plateau peoples, as did many other early explorers and naturalists (Cutright 1969).

During the Depression and World War II, when commercial food products were scarce and expensive, many Aboriginal People relied heavily on traditional plant foods, as well as some recently derived products. For example, Annie York mentioned the use of broad-leaved maple *(Acer macrophyllum)* sap by Nlaka' pamux during World War II as a sugar substitute (Turner et al. 1990). Introduced weeds, including burdock roots (*Arctium minus* L.), "Italian weed," or hedge mustard greens (*Sisymbrium altissimum* L.), mustard greens (*Brassica* spp.), dandelion greens (*Taraxacum officinale* Weber), and lamb's quarters (*Chenopodium album* L.) also became important foods for Aboriginal People during this period (Kuhnlein and Turner 1991).

## SUMMARY AND CONCLUSIONS

Food shortages have occurred for Aboriginal Peoples throughout northwestern North America since prehistoric times. Generally the occurrence of shortages was related to a combination of factors, including poor climatic or local weather conditions, the winter or early spring (nongrowing) season, low productivity of food resources in the previous year, low availability of fresh and/or stored food supplies, inability to obtain food through trade or other forms of exchange, and natural or human-caused calamities. Individuals, such as hunters, travellers, and those lost in the woods, also occasionally experienced hunger or starvation.

Plant foods have played an important role as famine or emergency foods, at least in part because their availability is more predictable than that of fish or game species. At least 100 different plant foods from northwestern North America have been documented as having had some role as foods in times of shortage or starvation.

Plant foods playing a role in alleviating hunger have been categorized into four general classes. The first includes foods normally eaten, but which, because of ready availability, especially in early spring, took on particular importance when other foods were not available. Identified with this category are: inner bark and cambium tissues from number of tree species (e.g., *Picea* spp., *Pinus* spp., *Populus balsamifera, Tsuga heterophylla*); red laver seaweed *(Porphyra abbottae);* nearly 20 species of shoots and young greens (e.g., *Balsamorhiza sagittata, Epilobium angustifolium, Lomatium* spp., *Rubus* spp.); and 30 "root" food species (e.g., *Camassia* spp., *Cirsium* spp., *Dryopteris expansa, Lilium columbianum, Lomatium* spp.); and a few fruits (e.g., *Viburnum edule*).

A second category, characterized as alternative foods, includes plant foods that, though used occasionally under normal circumstances, were not preferred. However, when regular, preferred foods were in short supply, these secondary foods were harvested and used in greater quantities. Examples are: inner bark of *Picea mariana;* mature stalks of *Epilobium angustifolium;* roots of *Glaux maritima, Polystichum munitum,* and *Lomatium gormannii;* and 28 less preferred fruits, such as *Berberis* spp., *Crataegus* spp., *Maianthemum dilatatum, Oemleria cerasiformis,* and various species of *Ribes* and *Rosa.*

The third class are the true famine foods—plant substances that were never eaten except in emergencies. Although there are many examples from other regions, there are few from northwestern North America. Some, such as the roots of *Lomatium dissectum* and *Lupinus* spp., may be toxic, especially if eaten raw; they were used out of desperation.

Finally, a miscellaneous class of plants used as hunger suppressants and thirst quenchers is identified. These would generally be used over short intervals of food or water deprivation, such as might be encountered by hunters, berry pickers, or travellers. They include substances such as leaves of three ericaceous plants *(Gaultheria shallon, Arbutus menziesii, Arctostaphylos uva-ursi),* young shoots of three conifers *(Pinus contorta, Pseudotsuga menziesii, Tsuga heterophylla),* and parts of two ferns *(Blechnum spicant, Polypodium glycyrrhiza)* which in diverse regions were chewed to relieve hunger or thirst.

All of these types of foods, even those that were less preferred, should be accorded a high degree of cultural significance because of their survival value. Some apparently provided critical nutrients, such as Vitamin C, as well as limited food energy. Some would have been potentially toxic if eaten in excess or without adequate preparation. The cultural aspects of the use of plant foods in times of scarcity are complex and multifaceted, including such factors as migration, establishment of social alliances, warfare, trade, food sharing, ritual and ceremonial practices, and myth. Although modern living in North America generally precludes the possibilities of famine or even general food shortages, the cultural knowledge surrounding such events has great significance, rendered even more important because it is rapidly disappearing.

## NOTE

[1]This is an excerpt from the first of two versions of a story entitled "Myth of the Salmon," or "Salmon His Myth," for which the original Kathlamet texts and word-by-word translations are also provided (Boas 1901:50–57).

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# BOOK REVIEW

**Global Biodiversity. Status of the Earth's Living Resources.** Brian Groombridge (editor). World Conservation Monitoring Centre. London: Chapman & Hall, 1992. 29.95 Pounds Sterling. ISBN–0–412–47240–6.

There are numerous aspects that immediately characterize this masterful production: its encyclopaedic coverage; the expertness throughout of the topics treated; the skillful tying together of the many concepts relevant to global diversity of life and environmental diversity; the easy-to-consult presentation of the material; and the stress on the interdisciplinary nature of conservation studies. It would indeed be difficult to exaggerate the utility of this outstanding volume which, for years to come, will be of great value to many individuals and organizations working in scientific, sociological and economic aspects of global biodiversity and of conservation of natural resources in general. Nothing remotely resembling this *Report* has ever been available; this novelty as well as its interdisciplinary character and coverage assure acceptance for many years amongst a great diversity of individuals in scores of academic, commercial and industrial fields—even many not directly concerned with biodiversity or environmental conservation.

As Dr. Robin Pellow, director of the World Conservation Monitoring Centre (WCMC), writes in the Preface: "In your hands, you now hold the most comprehensive review of global biodiversity ever compiled. It represents the product of numerous scientists, consultants and research institutes, each of whom has generously contributed data or assistance to the compilation of this *Report*, together with the substantial information holdings that WCMC already manages."

There are several brief initial essays: How to use the book; the WCMS; Acknowledgements (including the names of more than 225 individuals who either made major contributions or who assisted in the compilation of the book); Preface and Biodiversity—an Overview.

The greater part of the volume is admirably organized into three major Parts: I) Biological Diversity; II) Uses and Values of Biodiversity; and III) Conservation and Management of Biodiversity. Each of the Parts is divided into sections offering detailed discussions of numerous pertinent and specific topics; the total number of these sections reaches 157.

Part I has four principal subdivisions: Systematics and Diversity; Species Diversity; Species Loss; Habitats; and Ecosystems.

The two major subdivisions of Part II are: Uses of Biological Resources; and Valuing Biodiversity.

Part III comprises three subdivisions: National Policies and Instruments; International Policies and Instruments; and Biodiversity Convention.

Throughout the book each of the 35 essays has a list of references. The volume is extremely well illustrated with figures, graphs, maps and tables.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

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# HOPI CROP DIVERSITY AND CHANGE

DANIELA SOLERI
and
DAVID A. CLEVELAND
*Center for People, Food, and Environment*
*344 South Third Ave.*
*Tucson, AZ 85701*

ABSTRACT.—There is increasing interest in conserving indigenous crop genetic diversity *ex situ* as a vital resource for industrial agriculture. However, crop diversity is also important for conserving indigenously based, small-scale agriculture and the farm communities which practice it. Conservation of these resources may best be accomplished, therefore, by ensuring their survival *in situ* as part of local farming communities like the Hopi. The Hopi are foremost among Native American farmers in the United States in retaining their indigenous agriculture and folk crop varieties (FVs), yet little is known about the dynamics of change and persistence in their crop repertoires. The purpose of our research was to investigate agricultural crop diversity in the form of individual Hopi farmers' crop repertoires, to establish the relative importance of Hopi FVs and non-Hopi crop varieties in those repertoires, and to explore the reasons for change or persistence in these repertoires. We report data from a 1989 survey of a small (n = 50), opportunistic sample of Hopi farmers and discuss the dynamics of change based on cross-sectional comparisons of the data on crop variety distribution, on farmers' answers to questions about change in their crop repertoires, and on the limited comparisons possible with a 1935 survey of Hopi seed sources. Because ours is a small, nonprobabilistic sample it is not possible to make valid extrapolations to Hopi farmers in general. It is, however, possible for us to suggest some hypotheses about crop diversity and change based on our results and illustrated with examples. The fate of each FV depends on the unique combination of the biophysical and sociocultural environment of that FV. FVs will tend to be lost when changes in the local biophysical and/or sociocultural environment reduce the importance of the FVs' adaptation. FVs will tend to be retained when the biophysical and/or sociocultural environment remains the same, or changes in ways that increase the importance of the FVs' adaptation. When changes in the biophysical and sociocultural environments make loss of FVs possible, the availability of seeds and alternative food or other products will become important.

RESUMEN.—Existe un creciente interés en conservar la diversidad genética de los cultivos indígenas *ex situ* como un recurso vital para la industria agrícola. Sin embargo, la diversidad de cultivos es importante también para conservar la agricultura indígena de pequeña escala y las comunidades campesinas que la practican. La conservación de estos recursos puede ser mejor lograda, por lo tanto, asegurando su sobrevivencia *in situ* como parte de comunidades agrícolas locales como los Hopi. Los Hopi sobresalen entre los agricultores indios en los Estados Unidos de Norteamérica en cuanto a retener su agricultura indígena y sus variedades criollas de cultivos, pero poco se conoce de la dinámica de cambio y persis-

tencia en sus repertorios de cultivos. El propósito de nuestra labor fue investigar la diversidad de cultivos en la forma de repertorios de cultivos de algunos agricultores. Hopi individualmente, establecer la importancia relativa de las variedades criollas y las variedades no Hopis en esos repertorios, y explorar las razones para el cambio o la persistencia en dichos repertorios. Reportamos aquí los datos obtenidos en un estudio realizado en 1989 con una muestra pequeña (n = 50) y oportunista de agricultores Hopi, y discutimos la dinámica del cambio en base a comparaciones internas de los datos sobre distribución de variedades de cultivos, en base a las respuestas de los agricultores a preguntas sobre el cambio en sus repertorios de cultivos, y en base a las limitadas comparaciones posibles con un estudio hecho en 1935 sobre fuentes de semillas Hopis. Dado que la nuestra es una muestra pequeña no probabilística, no es posible hacer extrapolaciones válidas para los agricultores Hopis en general. Sí es posible, no obstante, que sugiramos algunas hipotesis sobre la diversidad y el cambio de los cultivos en base a nuestros resultados, ilustradas con ejemplos. El destino de cada variedad criolla depende de la combinación única del ambiente biofísico y sociocultural de tal variedad. Las variedades criollas tenderán a perderse cuando los cambios en el ambiente biofísico y/o sociocultural reducen la importancia de la adaptación de la variedad. Las variedades criollas tenderán a retenerse cuando el ambiente biofísico y/o sociocultural permanece igual, o cambia en forma tal que aumenta la importancia de la adaptación de la variedad. Cuando los cambios en los ambientes biofísicos y socioculturales hacen posible la pérdida de variedades criollas, la disponibilidad de semillas y alimento u otros productos alternativos adquirirá importancia.

RÉSUMÉ.—La conservation de la diversité génétique *ex situ* des plantes indigènes comme ressource vitale pour l'agriculture industrielle prend une importance grandissante. Toute fois, la continuité des pratiques traditionnelles ou indigènes des petites fermes agricoles demeure importante pour la conservation de la diversité génétique pour les populations pratiquant ce genre d'agriculture. Par conséquent, les ressources agricoles peuvent être mieux conservées en assurant leur survie *in situ* par une production traditionnelle à l'example des Hopis. La tribue Hopi est un groupe parmis les indiens Americains qui pratiquent une agriculture traditionnelle depuis des générations, cependant, peu d'information existe concernant les dynamiques de changements et la persistence du répertoire agricole des Hopis. Le but de notre recherche était d'investiguer la diversité génétique du matériel végétal des agriculteurs individuels Hopis, et d'établir l'importance relative des plantes locales et introduites, ainsi que d'explorer les raisons qui ont conduit au changement ou à la persistence du répertoire agricole des Hopis. Nous reportons ici les données d'un sondage de 50 agriculteurs fait en 1989 et discutons la dynamique de ces changements en se basant sur des comparaisons transversales des données sur la distributions des plantes cultivées, les réponses des paysans aux questionnaires concernant les modifications de leur répertoire agricole, et les comparaisons limitées de nos résultats avec ceux d'un sondage fait en 1935 sur les ressources en semences des Hopis. Nos échantillons de sondages sont petits en nombre, donc, il serait impossible d'extrapoler en général sur l'agriculture des Hopis. Il est possible cependant de suggérer des hypothèses concernant la diversité et les changements dans l'agriculture Hopis en se basant sur nos résultats, accompagnés d'examples illustratifs. Le destin de chaque variété locale cultivée dépend d'une combinaison unique de facteurs biophysiques et socioculturels se rapportant à la variété cultivée en question. Les variétés locales ont

tendance à disparaître quand les changements dans l'environment local biophysique ainsi que socioculturel entraînent la réduction de leur importance adaptive. Les variétés locales ont tendance à être retenues au sein du système de production si les facteurs biophysiques ou socioculturels restent identiques, ou changent d'une manière à rendre leur adaptation plus importante. Quand ces facteurs produisent des conditions favorables à la perte d'une variété locale, la recherche des semences, plantes ou produits de substitution devient importante.

## INTRODUCTION

There is growing evidence of an increasing rate of loss of cultural and biological diversity, of unprecedented environmental destruction, and of the instability and excessive cost of industrial agriculture systems (Brown, L. 1990; Ehrlich and Wilson 1991; NRC 1989). One response to the threat to agricultural diversity has been increasing interest in indigenous crop genetic resources (Keystone 1990, 1991; Plucknett et al. 1987:3–18). While most of this interest has been in conserving diversity *ex situ* as a resource for industrial agriculture, crop diversity is also important for conserving indigenously based, small-scale agriculture and the farm communities which practice it. There is increasing realization that different cultures and different environments make diverse demands of their farming systems which go beyond simple production (Cleveland and Soleri 1991:285–295). It is therefore important to understand the relationship between biological and cultural diversity in agriculture, including the ways in which both new and old crops and crop varieties fit the cultural and environmental needs of a society and its farming system.

Crops are one form in which diversity can be expressed in an agricultural system, and this diversity can occur at different levels. It is frequently the case that compared with "modern" crop varieties (MVs) produced for use in industrial agriculture, the folk crop varieties (FVs, also referred to as landraces or traditional varieties) of indigenous or traditional agriculture contain substantial genetic diversity (Frankel and Soulé 1981:179, 201–202). This diversity may be present within individual plants (heterozygosity), among individuals within a heterogeneous variety, among varieties within a species, or in the large number of species and varieties often grown by indigenous farmers.

In general, greater diversity in agriculture appears to be associated with greater stability, i.e., less variation in yield from year to year. Although not a closed issue, the contribution of diversity to stability in agricultural systems is widely supported by evidence in agricultural economics (Anderson and Hazell 1989; Barker et al. 1981), plant breeding (Borojevic 1990:333–334; Weitzien and Fischbeck 1990), and agroecology (Pimentel et al. 1992; Thurston 1992:193–211). Theoretically, therefore, a major benefit provided to low resource farmers by diverse, locally adapted crop varieties, like many FVs, and the low-input cropping systems of which they are a part, is a reduced risk of crop failure due to environmental variation or unavailability of outside inputs, as well as a sustainable source of seeds for future plantings (Clawson 1985; Soleri et al. 1991; Richards 1986:134–138; Thurston 1992:193–211). Industrialized agriculture usually lacks the crop genetic and management diversity of indigenous systems. This relative lack of diversity often means that in the event of a shortage of inputs, industrial

systems are more vulnerable to environmental conditions and therefore experience more yield variability (Anderson and Hazell 1989; Barker et al. 1981).

Efforts to conserve crop genetic resources have increased significantly in the last several decades with the growing recognition of their value for all agricultural systems, their loss due to replacement of FVs by MVs, and the loss of habitat of wild and weedy crop relatives (Wilkes 1989). This conservation effort has focused almost exclusively on collecting and saving these resources *ex situ* in gene banks (e.g., Plucknett et al. 1987:3–18). Recently, *in situ* conservation of crop genetic resources has been advocated as an essential complement to *ex situ* conservation (Altieri 1988; Brush 1989, 1991; Soleri et al. 1991; Oldfield and Alcorn 1987; Cooper et al. 1992).

Some of the biological benefits of *in situ* over *ex situ* conservation are maintaining the evolution of the crop variety under human and environmental selection, and avoiding loss of valuable alleles due to inadequate sampling strategy or sample size while collecting (genetic drift) or novel selection pressures during *ex situ* seed generation (genetic shift) (Wilkes 1989). However, for many, even more important benefits of *in situ* conservation are greater local access to and control of crop genetic resources and farming systems and survival of the communities supported by those farming systems (Altieri 1988; Cooper et al. 1992; Oldfield and Alcorn 1987). Ensuring that *in situ* conservation is in fact a reflection of local control and not external decision-making will be difficult. However, the potential benefits of *in situ* conservation can only be realized if this strategy makes sense to the farmers and gardeners who are participating. Farming communities that have maintained some of their FVs, especially in circumstances where seed for industrial MVs is readily available, are examples of indigenous *in situ* conservation. Identifying crop repertoires of such farmers, and understanding why and how these communities maintain their traditional crop genetic resources will provide insights valuable for supporting *in situ* conservation and for creating sustainable agriculture based on indigenous knowledge.

The Hopi are foremost among Native American farmers in the United States in retaining their indigenous agriculture and FVs, yet little is known about the dynamics of change and persistence in their crop repertoires. The scanty information available to outsiders is not adequate to address this question. The work of Whiting, who directed a survey of Hopi seeds in 1935 and published an ethnobotany of the Hopi, provides examples of the difficulty of reaching meaningful conclusions because of lack of data and the complexity of crop repertoire dynamics. In fact, many of Whiting's generalizations appear to be contradictory.

For example, on the one hand Whiting stated that "when it comes to seed, the Hopi will try anything once," and as a result only "a few" Hopi crops are "ancient," most of them having "been discarded in favor of other varieties which are easier to grow, yield better, and have better flavoring or are more easily prepared" (Whiting 1936:3). On the other hand, however, Whiting also stated that the results of trying new varieties "are often failures," and many crops grown by Hopi are "remarkably adapted to his particular environment, more so than those of the white man" (1936:3). In his Hopi ethnobotany Whiting compared contemporary Hopi varieties with those noted by Stephen (1936:353–354) and wrote that "Considering the intense interest of the Hopi in new varieties of crop plants and their

numerous introductions and experiments it is surprising that Hopi agriculture is as stable as it is. . . . This stability is due, in part, to the fact that new crops are often abandoned almost as quickly as they are introduced" (Whiting 1939:11).

Obviously, to understand the many different factors which determine changes in crop repertoires, and which may differ for each particular variety, it is necessary to have the data required first to frame, and then to test, specific hypotheses. The purpose of our research was to investigate agricultural crop diversity in the form of individual Hopi farmers' crop repertoires, to establish the relative importance of Hopi FVs and non-Hopi crop varieties in those repertoires, and to generate hypotheses to explain change or persistence in these repertoires. We report data from a survey of a small, nonprobability sample of Hopi farmers and discuss the dynamics of change based on cross-sectional comparisons of the data on crop variety distribution, on farmers' answers to questions about change in their crop repertoires, and on the limited comparisons possible with the 1935 survey of Hopi seed sources directed by Whiting.

## METHODS

Fieldwork was done between late summer 1988 and fall 1989. Hopis have been subjected to so much disturbance and questioning by outsiders for so many years that they are often understandably reluctant to spend much time talking with researchers. Because of this, our goal was not a probability sample, but rather to talk with some farmers in each village we visited by going from door-to-door, and by using referrals. This method was used by Carter (1945:11) in his survey of Native American crops. Because ours was a small, nonprobability sample, it is not possible to make valid extrapolations to Hopi farmers in general. It is, however, possible for us to suggest some hypotheses about crop diversity and change based on our results.

Farmers in Hotevilla, Bacavi, Kykotsmovi, Old Oraibi, and Shungopovi were contacted by Soleri and Cleveland in door-to-door visits (Fig. 1). Seven farmers were also interviewed by Gary Nabhan in Upper and Lower Moenkopi, the irrigated Hopi villages ajoining Tuba City. Over 60 farmers were interviewed, but only data from 50 of those were considered complete enough to be used in this report.

The majority of farmers interviewed were older, retired men. While men are usually responsible for the field work, care of the seeds from harvest until the next planting is the responsibility of women, and so in most cases farming is a collaboration between men and women. A husband-and-wife farming team often answered our questions together, discussing, confirming, or contradicting each other's responses. In a number of cases younger men would respond together with their mothers, or their mothers-in-law. One female farmer was also interviewed independently.

It seems very possible that this age distribution may have resulted in unrepresentatively large crop repertoires and a high proportion of Hopi varieties. Reasons for this include that the older men making up the majority of the sample have grown up and lived during a time when Hopi farming and ceremonial traditions were much stronger than they are today; they have more farming experience than younger Hopis; and they have more time to farm than do youn-

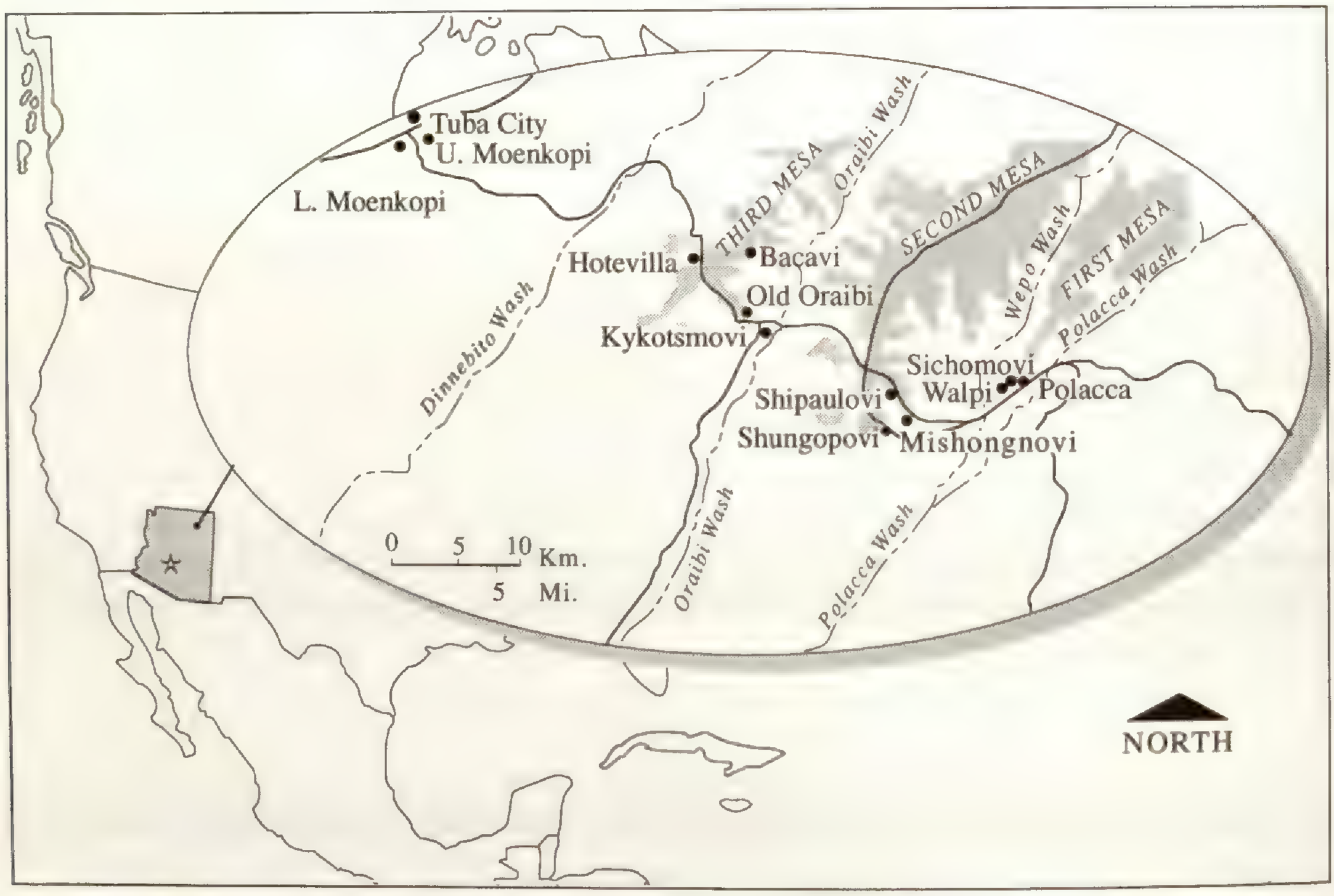


FIG. 1—Location of the study area in Arizona, U.S.A., showing the three Hopi mesas, the washes, and the Hopi villages mentioned in the text.

ger Hopis engaged in or seeking full time wage work. On the other hand, as these men get very old their farming decreases, especially if their children or their children's spouses do not farm. When data on corn varieties grown are grouped by broad, estimated age categories, households with older, male farmers have a higher average number of varieties: farmers less than 30 years old (n = 3), 5.0 varieties; farmers 30–60 years (n = 12), 6.2 varieties; and farmers over 60 years (n = 30), 6.8 varieties.[1]

Another potential source of misrepresentation was the tendency for people to assume that we wanted to, or should, only talk with the "best" farmers. We tried to avoid this problem by going door-to-door, not just using referrals. However, we suspect that some Hopis may simply have disqualified themselves because they did not feel that their farming activity or experience was adequate.

The interview schedule was a reference list of Hopi crop varieties with Hopi names based on Whiting's ethnobotany (1939), which he in turn based on the 1935 seed source survey (Whiting 1935, 1936, 1937), although he obviously used other sources. The names were written phonetically to assist interviewers. Using the schedule as an "ethnographic interview guide" is an approach currently being used by others for participatory research among Native American communities (Reidhead 1989). We did not attempt to identify the specific varieties of non-Hopi crops, since farmers often did not know the specific varieties, for example of "bush beans" or "sweet corn."

Based on this schedule we asked farmers "What crops do you grow?" from each crop category (corn, lima beans, melons, and so on). We purposefully de-

cided not to ask only what crops were being grown during the current year, as it appears may have been done in the 1935 survey, since farmers do not grow all of their crops each year and thus would not have mentioned many of the crops in their repertoires. We wanted to identify the crop varieties these farmers grow regularly and which they themselves consider to be a part of their repertoires. Thus the data collected were lists of crop varieties in farmers' current crop repertoires according to the farmers themselves.

*What is a FV?*—Determining which crops should be considered "Hopi" FVs and which should not was an important but difficult problem for our work. It reflects the larger problem of defining what constitutes a FV in studies of indigenous farmer management of crop genetic resources. The problem becomes even more complicated when trying to distinguish between a "Hopi" and "non-Hopi" variety whose fruits or seeds are morphologically very similar. Differences, if they exist, are in genotype, plant morphology, agronomic characteristics, or harvest quality, none of which could be consistently observed in this survey.

While frustrating for research which is inclined to place all crops into neat, discrete categories, this dilemma is an excellent reminder of the fluidity of living, nonindustrial farming systems in which human and environmental selection of crops is continuous. Perhaps because of these difficulties some researchers considering this problem have defined FVs as representing a management strategy, not genetic composition (Brush et al. 1988).

However, this neglects the effect of deliberate human selection, management strategies, and environmental factors on crop evolution, which is widely recognized by plant geneticists as the basis for FVs (Harlan 1992:127–128). The question is, do these varieties exhibit, or have the potential to exhibit, phenotypic differences which reflect significant genotypic differences present as a result of selection by local farmers and the local environment, or are they relatively recent introductions which have not been so influenced?

This is a difficult question to answer because a cutoff point will necessarily be arbitrary, and so there will be ambiguous cases. In this paper we use the imprecise but widely used definition of a FV (or landrace) as "geographically or ecologically distinctive populations which are conspicuously diverse in their genetic composition both between populations and within them . . . which evolved under cultivation" (Brown, A.D.H. 1978:145), and which are the product of local selection. The key words in this definition are "distinctive" and "conspicuously," which again of course imply an arbitrary judgement.

We assume that the named Hopi varieties reported by the farmers are FVs. However, we did not collect voucher specimens from farmers. We did look at and discuss seed, fruit, or plants of the crops whenever possible, and some farmers gave us samples which we used for our own reference. Some non-Hopi varieties were often further differentiated as "commercial," i.e., purchased. We use the term "commercial" to indicate non-Hopi varieties generally obtained commercially as opposed to non-Hopi varieties obtained from other sources such as other Native American groups. As previously noted, the names of non-Hopi varieties were much less precisely known by Hopi farmers, and varieties were often lumped together, and we did not differentiate them.

## HOPI AGRICULTURE AND CULTURE

Archeological evidence suggests that the Hopi Native Americans or their direct ancestors have lived for well over 1000 years in the area that is now the Hopi Reservation in northern Arizona (Brew 1979). Hopi agriculture, including FVs, appears to be the unique result of biophysical and sociocultural influences. It is probably one of the richest and most persistant of all Native American agricultures in the United States today, and yet remains relatively unknown to the outside world. Changes in Hopi agriculture during the last 100 years are dominated by reductions in areas farmed (Prevost et al. 1984) and proportion of people farming (Kennard 1979).

*The biophysical environment*.—The Hopi environment would challenge any farmer. Nonetheless, Hopi farmers and gardeners have developed an agricultural system which, through careful observation and skillful management, has sustained their communities for well over 1000 years.

The Hopi Indian Reservation is located in the high desert of northeastern Arizona, where the growing season between freezing temperatures is short, 120–160 days, depending on the location. Frequent drying winds, especially at the beginning of the growing season, and high summer temperatures produce high rates of evapotranspiration. These conditions, along with the lack of surface water and low and variable annual precipitation, makes water the resource most limiting to agricultural production. The topographical and geological features of the Hopi lands and those north of them have a major effect on the availability of water to Hopi agriculture and communities. The northeastern half of the existing reservation is the southern escarpment of Black Mesa, which rises to an elevation of approximately 2400 m.

Three mesas run southwest from Black Mesa, separated by four washes from east to west: Polacca, Wepo, Oraibi, and Dinnebito (Fig. 1). The mesas, now referred to as First, Second, and Third, from east to west, are over 1,830 m high at their southern points, where most of the Hopi villages are located. Although the village sites are rocky promontories with little or no vegetation, juniper and piñon pines dominate the higher areas of the reservation. In between the mesas and to the south of them, the washes spread out into flat, wide, undulating lowlands where wild grasses and small shrubs grow (Bradfield 1971:13; Prevost et al. 1984).

Under the USDA Land Capability Classification System, soils of the Hopi Reservation (classes VI and VII) are considered unsuitable for cultivation and appropriate for only moderate to limited grazing (Brady 1974:347–350; Prevost et al. 1984). Four soil types dominate the cultivated areas on the reservation: (1) a sand layer over loam in alluvial fans, (2) loam soils in seasonal water courses, (3) sandy soils in dunes and often over seeps, and (4) clayey soils in irrigated terraced garden beds (Hack 1942:36).

The southern, lower part of the reservation, where most agriculture occurs, receives an annual average of 15–23 cm of precipitation (Prevost et al. 1984). This precipitation can be highly variable within a marked seasonal pattern of summer rains coming between mid-July and mid-September, and rain and snow occurring

primarily from January through April. May and June are the driest months and are accompanied by strong winds.

The mesas on the reservation, and Black Mesa to its north, are composed of a permeable Mesa Verde sandstone layer overlying an impermeable layer of Mancos shale which slopes down as it runs south into the Hopi mesas (Bradfield 1971:7–9). Water from snow and rain falling north of Hopi percolates through the sandstone layer, is trapped on top of the shale, and follows its downward and southerly path until reaching the mesas. There the water may seep from the mesa sides, running under a layer of wind blown sand and moistening the heavier soil underneath. These seeps are where fruit trees, melons, squash, gourds, and beans are planted. Springs also occur and provide both drinking water and water for irrigating nearby terraced gardens.

Field production not only benefits from direct rainfall, but from spreading of runoff from summer rains, and from water stored in the soil from winter precipitation. Fields are traditionally planted by hand using a wooden or steel planting stick to dig a planting hole down through the sand and into the moist soil beneath. Planting depth increases during the course of the spring-summer planting season to accommodate rising soil temperatures and receding soil moisture. For corn this can mean a planting depth of over 25 cm, and Hopi FVs appear to be uniquely selected for this environment and planting practice (Bradfield 1971; Collins 1914a, 1914b). Many farmers now use tractors for cultivation and, with equipment especially adapted to place seed deeply, for planting, although they recognize that unlike hand planting this practice cannot adjust to variation in moisture within fields.

An early planting of corn is sometimes done in April, especially in fields which are known to have warm microclimates. Sweet corn and some early corn varieties like yellow and greasy hair are planted then in hopes of an early harvest in time for the ***Niman,***[2] or Home Dance ceremony, in July. The main planting of corn, beans, squash, melons, and gourds is in late May. Some crops may also be planted in July such as sweet corn and Hopi string beans which are both considered relatively fast (i.e., have a short time from planting to maturity).

*Society, culture, and agriculture.*—Today approximately 7,000 Hopis live on the reservation (Arizona State Data Center 1992) in 11 villages and another approximately 2,000 in Upper and Lower Moenkopi, which are not on the reservation according to boundary lines currently recognized by the Federal government. The Hopi Tribe estimates the annual population growth rate between 1970 and 1982 at 3%, and at about 2% from 1982–1986 (Hopi Tribe 1987).

The crops now grown by Hopi farmers are one point in a continually changing Hopi crop repertoire. Hopi have acquired their crops from different sources since they first began farming. A few are endemic wild or semidomesticated plants of the Hopi area, e.g., ***nanakopsi*** (Whiting 1939:16–17), while others were borrowed from nearby groups, e.g., tepary beans. Many of the most important crops were domesticated in Mesoamerica but were introduced into the Hopi area very early, e.g., corn, beans, and squash (Ford 1981). Many new crops were introduced from Eurasia and Africa by the Spanish, e.g., watermelon, peaches, and apricots, or from Mexico, e.g., chili peppers. Undoubtedly there was much exchange

of crops and crop varieties in prehistoric times. Like most farmers, Hopi are eager to try new seed, and there are historic records of borrowing from other Indian tribes, Mormon settlers, traders, and others (Whiting 1939:8–11). For example, a drought in 1864 "scattered temporarily" many Hopi and they returned "bringing new varieties of corn with them," and Hopis also obtained seed in 1915 at the first San Diego Exposition from other farmers (1936:3). "So it goes—traders, the Indian Agency, schools, friends—are all potential sources of seed. The Hopi farmers have discovered the mail order seed houses and the nurseries of Denver and Phoenix" (Whiting 1936:3). The crop varieties that become established in the Hopi crop repertoire are those that show promise, but are subsequently selected by the natural environment and people according to biophysical and sociocultural criteria, and thus become FVs.

Hopi ceremonial life is closely integrated with agriculture and the Hopi trace their farming tradition to their beginnings as a people. At the Creator's request they chose their varieties of corn and thus chose to be farmers, in contrast to the Apaches and Paiute who chose to be hunters and gatherers (Nequatewa 1967:30–31). As Frigout (1979:564) noted, "in a sense, all Hopi life is based on the ceremonies, which assure vital equilibrium, both social and individual, and conciliate the supernatural powers in order to obtain rain, good harvests, good health, and peace." Indeed, "rain is the most common request in Hopi prayer" (Heib 1979:580).

The annual Hopi ceremonial cycle, assisted for half of the year by the ***Kachinas*** or spirits, requires active year-round participation by the Hopi people. Although all villages perform some ceremonial activities, since the early 1970s only Shungopovi has continued to perform the full ceremonial cycle (Frigout 1979). Some Hopi interviewed in 1989 expressed concern over the future of the ceremonies in their village due to lack of interest among young people.

Agricultural products, especially from diverse traditional corn varieties, are essential for participation in the rich Hopi ceremonial life. Sponsorship of ceremonial and social dances and contributions of traditional food and other goods required for participation in these activities appear to help reinforce community ties, cooperation, and redistribution of wealth within communities (Kennard 1979). The emphasis is on harmony and cooperation, and disharmony and lack of participation are seen as the cause of many problems, such as poor rains and harvests. The cultural value of agriculture and FVs is an important reason for the continued interest in agriculture among Hopis (Kennard 1979; Prevost et al. 1984), even though many other forces work in the opposite direction.

Penetration of the market economy into the Hopi communities has discouraged food production in favor of income generating work, yet today such work is in short supply. Older Hopis talk frequently of how their ceremonies, agriculture, and ultimately Hopi culture are falling victim to the pursuit of the "almighty dollar." For young and middle-aged Hopis living on the reservation, finding work, especially rewarding work, is extremely difficult because their options are almost entirely limited to working for tribal or federal agencies or craft production for the tourist trade. The 1990 US Census found a 27% unemployment rate on the reservation with over 48% of the population living below the poverty line (Arizona State Data Center 1992). Among the unemployed, drug abuse exacerbates economic and social problems. For those who are working, farming and

TABLE 1.—Farmers growing Hopi and non-Hopi crop varieties.[1] Number of farmers interviewed = 50.

| Crop category | Number of farmers growing | Growing only Hopi varieties % | (no.) | Growing only non-Hopi vars. % | (no.) | Growing both Hopi & non-Hopi vars. % | (no.) |
|---|---|---|---|---|---|---|---|
| Corn | 50 | 48% | (24) | 0% | (0) | 52% | (26) |
| Lima beans | 42 | 86% | (36) | 0% | (0) | 14% | (6) |
| String beans | 40 | 48% | (19) | 7% | (3)[2] | 45% | (18) |
| Field beans | 40 | 45% | (18) | 10% | (4) | 23% | (9) |
| Tepary beans | 18 | 94% | (17) | 6% | (1) | 0% | (0) |
| Squash | 39 | 49% | (19) | 8% | (3) | 44% | (17) |
| Watermelons | 43 | 54% | (23) | 7% | (3) | 40% | (17) |
| Melons | 36 | 56% | (20) | 25% | (9) | 19% | (7) |
| Gourds | 30 | 100% | (30)[3] | 0% | (0) | 0% | (0) |
| Sunflower | 8 | 50% | (4) | 50% | (4) | 0% | (0) |
| Fruit trees | 36 | 64% | (23) | 6% | (2) | 31% | (11) |
| Garden vegetables | 26 | 0% | (0) | 92% | (24) | 8% | (2) |

[1]Does not include self-seeded crops and seeds donated by NS/S; totals may exceed 100% due to rounding.

[2]Grown in gardens only.

[3]One farmer is growing Hopi *and* a gourd from a New Mexico Pueblo.

ceremonial activities must be fit in around work schedules. One result of these sociocultural changes, and accompanying environmental problems, has been a 40% reduction in cultivated area on the reservation between 1950 and 1982 (Prevost et al. 1984), and a reduction in the proportion of people farming (Kennard 1979). Many older men and women in our survey commented on this, saying that Hopi farming may be dying out with their generation.

## RESULTS: FARMER CROP REPERTOIRES IN 1989

As shown in Table 1, Hopi FVs accounted for more than half the varieties in farmers' crop repertoires in 1989 with the exception of sunflowers and garden vegetables. However, in some crop categories dominated by Hopi FVs extensive farmer experimentation with commercial varieties is occurring.

*Corn.*—Corn *(Zea mays)* (Table 2) is the central crop in Hopi farmers' repertoires and was grown by all of the farmers interviewed for this survey. A total of 17 Hopi varieties were reported grown. ***Supai*** corn, named for seed markings which resemble Havasupai chin markings, is considered a FV by Hopi farmers. In addition there were five non-Hopi varieties: commercial sweet corn and commercial popcorn (these may include more than one variety), Pueblo blue corn, a "red corn from India," and a "giant field corn from a Vietnamese friend in California." It is worth noting that according to the farmers growing them, the last two varieties were experiments and therefore may not remain in their repertoires for long.

TABLE 2.—Farmers growing corn varieties. Varieties considered Hopi unless otherwise indicated.

| Variety | % Farmers (n = 50) | Variety | % Farmers (n = 50) |
|---|---|---|---|
| Blues | 100% | ***Supai***/chinmark ***(koninqua'ö)*** | 44% |
| "Standard" blue ***(sakwaqa'ö)*** | 82% | Greasy hair ***(wiqtö)*** | 36% |
| Hard blue ***(huruskwapu)*** | 10% | ***Kokoma*** | 24% |
| Gray blue ***(maasiqa'ö)*** | 24% | Speckled/owl ***(avatsa)*** | 12% |
| Pueblo blue[1] ***(nenengqa'ö, Hopoqa'ö?)*** | 4% | Pink ***(palatspipi)*** | 6% |
| Blue/***kokoma*** mixture | 12% | Commercial popcorn[1] | 4% |
| White ***(qötsaqa'ö)*** | 96% | Miscellaneous | 12% |
| Yellow ***(takuri)*** | 70% | Hopi beige ***(qöyaqa'ö?)*** | 1% |
| Hopi sweet ***(tawaktsi)*** | 64% | sweet pink | 1% |
| Red ***(palaqa'ö)*** | 62% | quilt ***(tavupqa'ö?)*** | 1% |
| Commercial sweet[1] ***(Pahaana tawaktsi)*** | 52% | small white | 1% |
| | | red corn from India[1] | 1% |
| | | field type from friend in California[1] | 1% |

[1]Non-Hopi variety or varieties.

However, commercial sweet corn seems to have become established in Hopi crop repertoires, with 50% of the sample growing it. Pueblo blue corn is considered to be a non-Hopi variety by the two farmers growing it, but appears to be an enduring part of the Hopi crop repertoire, and may be reborrowed at intervals from various Rio Grande Pueblos.

The mean number of corn varieties grown was 6.3, ranging from a high of 11 to a low of 2 varieties. Twenty-four of the farmers (48%) grow only Hopi corn varieties. For 22 of the remaining 26 farmers interviewed, the only non-Hopi corn they grow is commercial sweet corn. The other four grow another commercial corn variety in addition to commercial sweet corn. There may be more than one white corn variety, as Whiting (1939:67) found, though the farmers we talked with did not identify them.

*Beans.*—Hopi FVs of beans grown in 1989 included four lima *(Phaseolus lunatus)*, three string *(P. vulgaris)*, seven field *(P. vulgaris)*, and two tepary *(P. acutifolia)* bean varieties. Commercial varieties of lima, string, and field beans were also grown. Although not currently grown, several farmers recalled an "old type" of large bean which may be the scarlet runner bean *(P. coccineus)* (Table 3). Whiting (1939:81) stated that this is "occasionally raised by the Hopi," but this variety is not listed in the 1935 seed source survey forms.[3]

*Cucurbitaceae.*—Farmers were growing three Hopi FVS and six non-Hopi varieties of squash (*Cucurbita* spp.). The two species of squash listed by Whiting (1939:93) as being grown in the 1930s were also present in 1989 (Table 4). However, based on

TABLE 3.—Farmers growing lima bean, string bean, field bean, and tepary bean varieties. Varieties considered Hopi unless otherwise indicated.

| Variety | % Farmers (n = 50) | Variety | % Farmers (n = 50) |
|---|---|---|---|
| Lima beans | | Field beans | |
| Yellow ***(sikya hatiko)*** | 38% | Yellow ***(sikya mori)*** | 52% |
| Gray ***(maasi hatiko)*** | 76% | Pinto ***(Kastiil mori)*** | 32% |
| White[2] ***(qöötsa hatiko)*** | 48% | Commercial pinto[1] | 18% |
| Red[2] ***(pala hatiko)*** | 34% | Pink ***(pala mori)*** | 20% |
| Commercial "baby"[1] ***(tsatsaymori)*** | 6% | Anasazi analogue ***(povo'khoi-mo'ri, woka'smori)*** | 6% |
| | | Grease ***(wi mori)*** | 4% |
| String beans | | Rotten ***(peekya mori)*** | 4% |
| Purple ***(qöma'fva'pu)*** | 56% | Black? ***(qömaf'mori)*** | 4% |
| White ***(qötca'va'pu)*** | 40% | Commercial bush[1] | 4% |
| Red ***(pala'va'pu)*** | 28% | | |
| Commercial[1,3] | 42% | Tepary beans | |
| | | White tepary ***(qööts tsatsaymori)*** | 30% |
| | | Black tepary ***(qömaf tsatsaymori)*** | 6% |

[1]Non-Hopi variety or varieties.

[2]Morphologically similar to commercially available variety, therefore possible non-Hopi contribution to the genepool.

[3]Includes green and yellow, pole and bush beans; only two of the 21 farmers growing non-Hopi string beans grow them without irrigation, the rest are grown under irrigation, either in gardens or in Moenkopi.

samples of fruit and seeds seen during this survey, it appears that ***Hopipatnga*** was mistakenly classified in the *Ethnobotany of the Hopi* (Whiting 1939) as *C. moschata,* when it is instead *C. argyrosperma* (formerly *C. mixta*). These squash can grow to be quite large with thick, hard shells which give them a long storage life. The shells can be made into a musical instrument ***(rukunpi)*** used in the ***Niman*** ceremony. They are also used as vessels, and the ground seeds are used in ***Kachina*** face paint, according to several farmers we spoke to.

Farmers were growing both red and yellow varieties of Hopi, and red and yellow varieties of commercial, watermelons *(Citrullus vulgaris)* (Table 4). Crushed watermelon seeds are used to lubricate stones on which ***piki*** (traditional, wafer-thin cornbread) is baked. An important characteristic of traditional watermelon varieties grown by Hopi farmers was their storage life. These small, round water-melons could be kept in a cool, dry corner of the house without spoiling until as late as May of the following year, as was the case in one house we visited. Whiting mentions the disillusionment of Hopis with the poor keeping qualities of the new varieties they experimented with (Whiting 1939:92), and several farmers men-tioned this to us as well.

TABLE 4.—Farmers growing Cucurbitaceae varieties. Varieties considered Hopi unless otherwise indicated.

| Variety | % Farmers (n varies) | Variety | % Farmers (n varies) |
|---|---|---|---|
| Squash (n = 50) | | Melons (n = 49) | |
| ***Hopipatnga*** *(Cucurbita agyrosperma)* | 64% | Hopi casava ***(kasaava)*** | 25% |
| ***Momonvatnga***[2] *(C. maxima)* | 34% | Commercial casava[1] | 22% |
| Gray[3] | 2% | Hopi cantelope ***(melooni)*** | 20% |
| Navajo gray[1,3] | 2% | Commercial cantelope[1] | 10% |
| Commercial zucchini[1,4] | 22% | Hopi muskmelon ***(melooni)*** | 27% |
| Commercial yellow[1,5] | 10% | Commercial muskmelon[1] | 8% |
| Commercial jack-o'-lantern[1] | 8% | Misc. Hopi melons[9] ***(melooni)*** | 16% |
| Commercial scalloped[1,6] | 4% | Misc. commercial melons[1,9] | 16% |
| Commercial banana[1,7] | 2% | | |
| | | Gourds (n = 49) | |
| Watermelons (n = 49) | | Rattle | 53% |
| Hopi red[8] ***(kawayvatnga)*** | 65% | Dipper | 16% |
| Commercial red[1,8] | 31% | Dipper[1,9] | 2% |
| Hopi yellow ***(sikyavatnga)*** | 57% | Bilobal | 18% |
| Commercial yellow[1,8] | 12% | Horn | 8% |
| | | Miscellaneous gourds[10] | 6% |

[1]Non-Hopi variety or varieties.

[2]Old type, but also available from commercial seed sources.

[3]Not clear if these different, both at Hotevilla.

[4]Five of the 11 farmers grew this in gardens.

[5]Two of the five farmers grew this in gardens.

[6]One of the two farmers grew this in gardens.

[7]Grown in gardens.

[8]More than one variety.

[9]From New Mexico Pueblos.

[10]Catch-all categories used when distinction between different varieties was not or could not be made.

Three varieties of Hopi melon and three commercial varieties were grown in 1989. Confusion about, and mixing of, various *Cucumis melo* varieties need to be taken into account when considering the findings in Table 4. The "miscellaneous" category for both Hopi and commercial melons reflects some of this confusion. Whiting (1939:93) also mentions the difficulty of categorizing these melon varieties.

Over half of the farmers grew rattle gourds, and several farmers grew other types of gourds *(Lagenaria siceraria)* (Table 4) and either sell or give them away to others. A long season, difficult-to-grow crop, gourds are in high demand for making rattles, especially for children's gifts during ***Powamuyaw*** and ***Niman*** ceremonies. The rattles are also popular with tourists. Specific gourd forms have special ceremonial uses: rattles, musical instruments, decoration/costume, and water carriers. Gourd seeds, especially for the appropriate shapes, are not as

TABLE 5.—Farmers growing fruit trees.

| Variety | % Farmers | n[2] |
|---|---|---|
| Hopi peach[3] ***(sipala)*** | 80% | 39 |
| Commercial peach[1,4] ***(sipala)*** | 25% | 40 |
| Hopi apricot ***(söhösipala)*** | 69% | 39 |
| Commercial apricot[1] ***(söhösipala)*** | 8% | 39 |
| Hopi pear ***(homi'sipala)*** | 18% | 39 |
| Commercial pear[1] ***(homi'sipala)*** | 13% | 39 |
| Hopi apple ***(mansaana)*** | 21% | 38 |
| Commercial apple[11,5] ***(mansaana)*** | 29% | 38 |
| Hopi grape ***(oova)*** | 26% | 39 |
| Commercial grape[1] ***(oova)*** | 10% | 39 |
| Commercial plum[1,5] ***(palaspala)*** | 5% | 40 |
| Hopi almond ***(sipa'ltuva)*** | 5% | 40 |
| Commercial cherry[1] | 3% | 40 |
| Commercial nectarine[1] | 3% | 40 |

[1]Non-Hopi variety or varieties.

[2]The number of farmers responding differs slightly for the different fruit tree varieties.

[3]Two or three varieties: cling, non-cling, yellow, white.

[4]Especially "Alberta."

[5]Two varieties.

readily available commercially as are those of many food crops. The greatest opportunity for obtaining seeds of new varieties is from the New Mexico Pueblos, and one farmer reported growing a dipper gourd from this source.

*Dye plants.*—The black seeded sunflower, ***(tceqa'a)*** *(Helianthus annuus),* a unique Hopi variety, has been grown by the Hopi as a source of dark colored basketry and textile dye, and for medicinal purposes. Only six (12%) of those interviewed said they grow this distinct FV, while five (10%) grow commercial sunflowers.

One person said that ***komo*** *(Amaranthus cruentus)* was volunteering in her garden. This was commonly grown in the past, along with ***asafrani*** (safflower, *Carthamus tinctorius*) (Whiting 1939:74, 95), and used to color ***piki*** pink and yellow, respectively.

*Fruit trees.*—We were not able to determine the specific variety of fruit trees in many cases, and so the six Hopi and eight non-Hopi varieties listed often represent more than one variety each (Table 5). Some farmers had trees that were planted by their parents and were not sure of the variety, often just calling them the "old Hopi type." Most fruit trees are grown without irrigation and must be able to withstand strong winds. Old peach trees were the most commonly named fruit tree, and had the most recognized varieties. However there appears to be substantial experimentation with new species and varieties, often obtained from nurseries in Utah. In the past, Hopis split and sun-dried peaches for storage through the winter (Kennard 1979; Whiting 1939:79). Today this is rarely done

TABLE 6.—Garden vegetables grown by ho· seholds with irrigated household gardens. Varieties Hopi unless otherwise indicated.

| Variety | % Gardeners (n = 28) | Variety | % Gardeners (n = 28) |
|---|---|---|---|
| Chili ***(tsiili)*** | 7% | Commercial cucumber[1] | 14% |
| Commercial chili[1] ***(tsiili)*** | 68% | Commerical pea[1] | 7% |
| Commerical onion[1] ***(siiwi)*** | 57% | Commerical carrot[1] | 7% |
| Commerical tomato[1] ***(tomaati)*** | 50% | Commercial lettuce[1] | 7% |
| Commercial radish[1] | 25% | Amaranth[1,3] ***(komo)*** | 7% |
| Commercial cilantro[1,2] ***(kora'nro, sila'ntro)*** | 14% | *Monarda menthaefolia*[3] ***(nanakopsi)*** | 7% |

[1]Non-Hopi variety or varieties.

[2]Hard to determine if Hopi variety exists; two gardeners planted purchased seeds, two obtained seed from family and/or had volunteer plants.

[3]All of these self-seeded.

according to the farmers we interviewed, although a few women said they make jams with the fruit.

*Garden vegetables.*—Hopi irrigated gardens include significantly greater numbers of new, non-Hopi crops and varieties than are grown in the dry-farmed fields (Table 6). Only two Hopi varieties were grown: chili and ***nanakopsi.*** Chilis are by far the most important garden crop, while other garden crops appear to change significantly from year to year. Only two gardeners were growing Hopi chilis. Many of the respondents in this category were women in the farming households sampled in Hotevilla, which has a large, irrigated garden area (Soleri 1989).

The responses reported in Table 6 are only for vegetables which are grown using irrigation *and* which do not fit into other crop categories. For example, chilis are listed here but the string beans grown in gardens are included in Table 3 with dry-farmed string beans. This was done because the focus of this study is crop repertoires, not agricultural management practices.

## DISCUSSION: CHANGING HOPI CROP REPERTOIRES

The Hopi, like most farmers and gardeners, enjoy experimenting with new crops or crop varieties. As new varieties are added to farmers' repertoires, old ones may be dropped. If retained long enough, new varieties become FVs through the process of evolutionary genetic change driven by biophysical and socio-cultural selection pressures.

During our field work, farmers frequently pointed out that commercial seeds are for irrigated agriculture. For some this was a reason not to try commercial seeds. Of the Hopi farmers interviewed who did experiment with commercial or ***Pahaana*** (Anglo) varieties for field agriculture, some explained that any seeds which grow successfully in their fields for more than two years "become Hopi."

That is, they adapt, and if desirable are adopted into the farmer's repertoire, at least for a while. This technique was mentioned by some in the case of commercial sweet corn, while others disagreed. At what point farmers begin thinking of a variety as "Hopi," i.e., at what point it becomes a FV subjectively, and what relation this has to genetic changes, is an important question that has rarely been investigated and is beyond the scope of our study.

We focused our questions on discovering the factors affecting farmers' decisions to adopt a new crop or variety, or drop an old one. It is likely that both environmental and sociocultural factors are important, but how these are balanced in the case of each crop or variety is unique. Zimmerer (1991), for example, found that Quechua farmers in the Peruvian Andes maintain diverse varieties of potatoes mainly for cultural reasons, and diverse varieties of corn mainly for production and consumption reasons. Hernández X. (1985) found in a study of corn in the greater southwest that diverse varieties are maintained by indigenous groups to meet a variety of ecological, consumption, and medicinal-ceremonial requirements, and suggested that color is used as an indicator of these characteristics.

In the following sections we first discuss the relevance of the 1935 crop survey to understanding change in crop repertoires. We then illustrate mechanisms of change with case studies of five crops: blue corn, sweet corn, beans, dye plants, and fruit trees, using cross sectional data from our survey and statements about change by the farmers.

*Varieties named in 1935 and 1989.*—It would be ideal to compare crop varieties in 1989 with those grown by the Hopis at an earlier date. Indeed, one of the inspirations of this research was the possibility of making such a comparison with the only survey of Hopi seeds that had been conducted. In 1935 ethnobotanist Albert Whiting and his colleagues, Volney Jones and Edmund Nequatewa, conducted this survey to find the source and distribution of Hopi farmers' crop seeds (Whiting 1935, 1937).

Whiting's seed source survey provides interesting insights into the agricultural crop repertoires of the farmers contacted, and the possible number of non-Hopi crops in those repertoires. However, neither of these topics was the focus of the survey, and no clear distinction was made between immediate source of seeds and the origin of the crop variety. The goal of the survey done by Whiting, Jones, and Nequatewa was to determine "seed source" "on the Reservation" and "off the Reservation," not Hopi vs non-Hopi nature of the seed, and there is a great deal of ambiguity in Whiting's typed field notes, which are apparently based on notes taken by Nequatewa, who did the actual interviewing. The 1935 seed source survey found that Hopi farmers in the sample obtained seeds from off the reservation in 33% of the cases. Seeds of many varieties obtained on-reservation are not identified with a Hopi varietal name, but only with adjectives such as "old" or "house," or "from Husband's family" or "from Moenkopi," or not further identified at all. A total of 619 "cases" of seed acquisition were reported, ranging from 16 for sweet corn and chili to 120 for beans (Whiting 1937).

The crop categories used by Whiting (1937) can be placed into two distinct groups: those crops for which the great majority of seeds were from an on-reservation source: corn (93%), beans (83%), squash and gourds (94%), chili (100%);

and fruit and vegetables for which seeds came from on-reservation sources in only half or less of the cases: melons (28%), fruit trees (51%), onions (13%), and vegetables (26%). This suggests that those crops of more ancient origin which are also more important in Hopi subsistence and culture were maintained through seed sources on the reservation. In comparison, crops which are more recent additions to the Hopi crop repertoire, have little if any significance in Hopi cultural tradition, and are not as important for subsistence, were more likely to be obtained from off-reservation sources.

Soon after we began our survey we realized that the seed "source" criteria used by Whiting in the 1935 survey is not a reliable indicator of whether or not seeds are Hopi. Seeds obtained on the reservation are not necessarily of Hopi crops, and now it is even possible to get seeds for Hopi crops from non-Hopi sources. For example, seeds for Hopi crops are now available commercially through groups like Native Seeds/SEARCH (Arizona), Seeds of Change (New Mexico), and others. A farmer may get commercial sweet corn or watermelon seeds from relatives and friends, and ***Kachinas*** distribute seed mixes which include non-Hopi varieties of crops including beans, melons, and sunflowers, as we observed in 1989. It is also quite possible that in 1935 non-Hopi seeds were being distributed by on-reservation sources such as relatives, friends, and ***Kachinas.***

Both the 1935 and 1989 surveys were of small, nonprobability samples of Hopi farmers. Therefore the only statement of comparison that can be made between the two surveys is that varieties named in both surveys were not lost to Hopi during the 54 years which separates them. This of course assumes that varietal names refer to the same FV at both times, since voucher specimens were not collected in either survey.

Table 7 compares the named varieties in the 1935 and 1989 surveys.[4] It is much more accurate for Hopi FVs than for non-Hopi varieties. We can see that 36 field crop and 5 fruit and vegetable FVs were named in both surveys and therefore were not lost. Of the 11 FVs named in 1935 and not in 1989, we can only say that it is possible (not probable) that they have been lost, and of the 16 FVs named in 1989 and not in 1935, we can only say that it is possible (not probable) that they have been reintroduced to Hopi farmers or have changed from non-Hopi to Hopi varieties in the intervening 54 years. This limited evidence suggests that there has been a high rate of retention of FVs over the last half century. The comparison of non-Hopi varieties suggests that they make up a large proportion of fruit and vegetable varieties and a small but increasing proportion of field crop varieties. The fact that a variety is still present does not mean that no loss of genetic diversity has occurred, since significant reductions in population size may be a source of loss.

*Blue corn.*—Hopi blue corn varieties can range in color from nearly black to a powdery grey color, depending on the pigmentation in the alleurone layer of the endosperm, or a combination of this and a red pericarp from mixing with ***kokoma.*** The existence of different varieties of blue corn was usually not mentioned until we asked specifically if there is more than one variety of Hopi blue corn. Of those who were asked this question (n = 39), 92% said there is more than one variety of Hopi blue corn. The varieties included "standard" blue ***(sakwaqa'ö),*** hard blue

TABLE 7.—Varieties named in the 1935 and 1989 surveys.

| | 1935 and 1989 | | 1935 only | | 1989 only | |
|---|---|---|---|---|---|---|
| Crop | Hopi | non-Hopi | Hopi | non-Hopi | Hopi | non-Hopi |
| Field Crops | | | | | | |
| Corn | 13 | 1 | 2 | 3 | 5 | 3 |
| Lima beans | 3 | 0 | 0 | 0 | 1 | 1 |
| String beans | 3 | 1 | 0 | 0 | 0 | 0 |
| Field beans | 6 | 1 | 6 | 2 | 1 | 1 |
| Tepary beans | 1 | 0 | 0 | 0 | 1 | 0 |
| Squash | 2 | 1 | 0 | 0 | 1 | 5 |
| Watermelons | 2 | 0 | 0 | 0 | 0 | 2 |
| Melons | 1 | 3 | 1 | 1 | 2 | 0 |
| Gourds | 4 | 0 | 0 | 0 | 1 | 1 |
| Dye plants | 1 | 1 | 2 | 0 | 1 | 0 |
| Total | 36 | 8 | 10 | 6 | 13 | 13 |
| Fruit Trees and Garden Vegetables | | | | | | |
| Fruit trees | 3 | 7 | 0 | 1 | 3 | 1 |
| Garden vegetables | 2 | 6 | 1 | 6 | 0 | 3 |
| Total | 5 | 13 | 1 | 7 | 3 | 4 |
| Total All Crops | 41 | 21 | 11 | 13 | 16 | 17 |

***(huruskwapu),*** and grey-blue ***(maasiqa'ö).*** Table 2 shows the distribution of those varieties in the crop repertoires of farmers interviewed.

Despite the high proportion of farmers who recognize more than one variety of blue corn, 62% (31) grow only one variety, 34% (17) grow two, and only 4% (2) grow three blue corn varieties. While recognizing the different varieties some people added that they are now mixed together, especially ***sakwaqa'ö*** and ***maasiqa'ö.***

One possible reason for this mixing, or compression, of blue corn varieties may be that some of the attributes or shortcomings of particular varieties are no longer important. For example, because of its hard kernels ***huruskwapu*** was mentioned as being resistant to storage pests. However, an increasing use of commercially produced foods mean that today households no longer need to store a year's worth of harvest in case of crop failure, therefore storage problems are less important (Whiting 1939:11). Similarly, we were told by several interviewees that when all the grinding was done by hand women preferred using a lot of ***maasiqa'ö*** which is soft and easier to grind, even though it may not give as good a blue color to the food as ***sakwaqa'ö*** or ***huruskwapu.*** In the 1930s it appeared to Whiting that "the harder varieties of corn are being replaced by similar but softer varieties that are easier to grind" (Whiting 1939:11). Yet today virtually all grinding is done by machine, and this quality has lost its importance, according to those we spoke with.

The agronomic differences among these blue corn varieties could also affect farmer selection and would be an important avenue of investigation. Of those who responded to a question about which variety of corn which would do best in

a dry year (n = 21), 29% said ***huruskwapu.*** Twenty-four percent said ***sakwaqa'ö*** would do best (one of those only recognized one blue corn variety), and 29% said both ***sakwaqa'ö*** and white corn did the best in dry years (one of those also only recognized one blue corn variety). ***Maasiqa'ö*** was never mentioned as a variety that is particularly good for dry conditions. Taking a different approach to drought adaptation, three farmers (14%) said that yellow corn ***(takuri)*** would probably do the best because it is "fast," that is it has a short growing season and therefore could produce a harvest before the stress of drought would affect it.

***Kokoma,*** a dark red-purple corn whose ear is morphologically similar to ***sakwaqa'ö,*** is considered a part of the blue corn complex because it is used to enhance the blue color. The pericarp of ***kokoma*** is the source of its purple kernel color (Brown et al. 1952), and it has a characteristic red cob distinguishing it from other varieties with similar kernel color such as red corn ***(palakaö).*** Of the 18 people who reported growing ***kokoma,*** 33% of them use it as a planting admixture in ***sakwaqa'ö*** to deepen and enhance the blue corn's color.

Another factor which could be affecting the blue corn varieties in these Hopi farmers' repertoires is availability of seeds. Until recently, in the United States blue corn foods and seeds were only known and available in a few areas of the Southwest. For Hopi farmers wanting to experiment with new varieties of this important staple and ceremonial food crop the only sources of new genetic material were neighboring agricultural tribes, especially the New Mexico Pueblos and the Havasupai (Whiting 1939:67–68).

The current blue corn fad has been accompanied by a rise in seed companies selling blue corn seed. The availability of commercial blue corn seeds and blue cornmeal may have an effect on Hopi agriculture and social activities. And yet, 96% of the farmers interviewed reported growing Hopi white corn even though commercial white flour corn varieties are available, as is white corn meal. Combined with farmers' perception of Hopi white corn as drought hardy, as compared with non-Hopi white corn varieties, this suggests that environmental adaptation is one reason for retention of this crop, possibly in combination with culinary qualities and cultural meaning. Collins (1914a, 1914b) found evidence that Hopi and Navajo corn has been selected for adaptation to the local environment and traditional planting technique. He observed two unique morphological features: an elongated mesocotyl, allowing successful emergence from such a deep planting; and a dominant, deep radical, enabling the seedling to make use of moisture far below the soil surface.

*Sweet corn.*—Sweet corn is an extremely interesting crop in the Hopi farmer's repertoire for several reasons.

(1) Sweet corn ***(tawaktsi)*** is traditionally used in the ***Niman*** ceremony in July. ***Niman*** marks the beginning of the harvest and thus the return to the San Francisco Mountains of the spirits or ***Kachinas*** who assisted the agricultural cycle by bringing rain. This is one of the most important ceremonies of the year, especially in the eyes of children, who receive toys and other gifts, including sweet corn.

(2) Sweet corn is a very popular garden crop in the USA, grown by 34% of gardeners in 1986 (Bruce Butterfield, personal communication, 1991[5]). The popu-

TABLE 8.—Farmers growing Hopi and commercial sweet corn.

| Description | All Farmers (n = 50) % | Without Moenkopi (n = 43) % | Moenkopi only (n = 7) % |
|---|---|---|---|
| Grow no sweet corn | 24% | 23% | 29% |
| Hopi sweet corn | 64% | 70% | 29% |
| Commercial sweet corn | 50% | 49% | 57% |
| Only Hopi sweet corn | 26% | 28% | 14% |
| Only commercial sweet corn | 12% | 7% | 43% |
| Both Hopi and commercial | 38% | 42% | 14% |

larity of sweet corn as a garden crop is reflected in the many commercial varieties of seed available.

(3) The popularity of sweet corn as a food means that it is usually easy to find in some form year-round in most food stores, and at farmers' markets and roadside stands in season.

Sweet corn, therefore, differs from blue corn because both as seeds and as food it is readily available to Hopi consumers. Hopi farmers' crop repertoires appear to reflect the availability of commercial sweet corn and sweet corn seeds (Table 8). Unlike any other corn variety, half the farmers interviewed grow a commercial sweet corn variety. Yet, at the same time 64% continue to grow Hopi sweet corn. In addition, in spite of its ceremonial importance, 24% of those interviewed do not grow sweet corn. Many of them said that this is because sweet corn is easy to buy at irrigated Anglo farms near Winslow and Flagstaff.

Commercial sweet corn seems to be a satisfactory substitute for Hopi sweet corn, and many people remarked about the larger ear size and sweeter flavor of commercial varieties. Stalks of sweet corn with the ears still attached are used during the *Niman* and one astute Anglo farmer near Winslow has responded to this consumer demand by allowing Hopis to cut their own stalks in his field.

Seven out of the 10 farmers who were asked specifically about the difference between Hopi and commercial sweet corn varieties said that the commercial ones need more moisture. Of the remaining three, one described how he mixes seeds of Hopi sweet corn in with those of a commercial variety to make the commercial one better adapted. Another farmer said that if the commercial variety makes it through one year it will be alright and they will save the seeds. Although the third farmer had heard that commercial varieties "grow stronger" he only grows Hopi sweet corn.

Those who do grow a commercial sweet corn variety often said they put it in "good" (i.e., moist, fertile) fields. A number of farmers had stories of crop failure with commercial varieties, saying that those varieties will die in a bad year while Hopi sweet corn will produce something, even if the plant is stunted and drought stricken. Two farmers interviewed who now grow only Hopi sweet corn described

a drastic deterioration in the quality of their crop each successive year after saving seeds from a commercial variety, perhaps because the commercial variety was a hybrid. However, as described above, some of the farmers growing commercial sweet corn say they save the seed and have done so for years, and others that they purchase the seed every year.

In spite of the small numbers, it is interesting to note the contrast between the farmers interviewed in irrigated Upper and Lower Moenkopi and farmers interviewed in the other dry-farmed villages (Table 8). In the two irrigated villages 43% grow only commercial sweet corn, while just 7% of the farmers we spoke with in the dry farmed villages grow only commercial sweet corn. At the same time, 70% of farmers interviewed in the dry farmed villages grow Hopi sweet corn, while only 29% do so in Upper and Lower Moenkopi. The obvious question is, are these results in some way related to the availability of irrigation water? While a larger, more in-depth survey is needed to assess this, these findings are suggestive of the influence of environmental constraints on crop repertoires. However, Moenkopi crop repertoires may also be a reflection of Hopi communities which are both physically and culturally closer to the dominant Anglo culture.

Carter (1945:57–58) said sweet corn was a relatively recent (approximately AD 1300) introduction to the Hopi crop repertoire. It is not as important as the flour corn varieties in Hopi culture. This may have facilitate its replacement with non-Hopi varieties when the opportunity arises.

*Beans.*—Like corn, beans (*Phaseolus* spp.) have been important both as a food crop and in ceremonies, most notably the ***Powamuyaw.*** The ***Powamuyaw*** is "a world renewal ceremony . . . to ready the children for initiation into the ***Kachina*** cult and encourage the cooperation of the ***Kachinas*** during the approaching growing season" (Mora 1979:36). During this winter ceremony lima beans are sprouted in the kivas to gauge how productive the coming season will be.

Pinto beans are similar to sweet corn in terms of seed and food availability. As with sweet corn it appears that widespread availability of seeds and food creates a complex dynamic between abandonment, retention, and elaboration of the crop variety in the farmers' repertoire. Sixteen farmers grow "Hopi" pintos. While many of these emphasized that their seeds were an old Hopi type, a number also noted that this variety has not always been a part of the Hopi farming system, as is suggested by the Hopi name ***Kastiil mori*** which means Mexican bean. Whiting (1939:83) identified a pinto ***Hubbell mori*** in the 1935 survey which was named after the trader who was said to have given the seed to the Hopis in the early 1930s. Nine farmers grow non-Hopi pintos and several of those explained how easy it is to find this seed (as food or feed) in grocery or feed stores or (as seed) in plant nurseries. Many respondents said they do not bother to grow pinto beans because they are so easy and inexpensive to buy.

Two older farmers (over 60 years old) whom we interviewed noted that yellow Hopi lima beans tend to dehisce easily when the pods are ripe, making them difficult to harvest. For those farmers this is the reason they no longer grow that lima bean variety.

***Tsatsaymori*** is a Hopi name meaning "small beans" (Whiting 1939:80). Tradi-

tionally this referred to white tepary beans *(Phaseolus acutifolia),* but also included black and mottled varieties, according to Whiting. The name describes a broad category and appears to be used today for any small field beans. During this survey ***tsatsaymori*** was used by informants to refer to samples of white teparies *(P. acutifolia),* black beans *(P. vulgaris),* and baby white limas *(P. lunatus).*

When talking about ***tsatsaymori*** all interviewees mentioned how difficult it is to grow these beans because rabbits and grasshoppers eat the leaves so voraciously, implying that those pests prefer ***tsatsaymori*** leaves over those of other crops. It would be interesting to investigate whether all of the smaller-seeded beans are more vulnerable to grazing by rabbits and grasshoppers. Another possibility is that the reputation of teparies, described by Whiting as the "true" ***tsatsaymori,*** is being transferred to other beans which are now included in the category ***tsatsaymori.***

Seven (14%) of the farmers we interviewed no longer grow ***tsatsaymori*** because the rabbit and grasshopper problem makes it too difficult to produce a good harvest. Several farmers described making a spray by steeping dog feces in water and spraying this on their plants, and one told us that he had to spray the plants every evening the last time he grew ***tsatsaymori*** several years ago.

Two of the households interviewed which are growing large amounts of ***tsatsaymori*** are both headed by an active husband and wife farming team, who are retired from their wage work and are now full-time farmers. In both cases ***tsatsaymori*** are purposefully grown in fields located near houses where more dogs are present, and it is easier to watch for and control rabbits. It may be that the amount of work necessary to produce a harvest is leading to the abandonment of this crop. This could be especially true as more and more Hopis must farm in their spare time while working full-time jobs outside the home.

*Dye plants.*—Dye plants appear to have been some of the most vulnerable to abandonment in the Hopi farming system, though to different degrees and for different reasons. In all cases they have been replaced by commercial chemical dyes.

Whiting (1939:95) cites Fewkes (1896) as saying that the Hopi obtained ***asafrani*** or safflower *(Carthamus tinctorius)* from the Mormons around 1870. ***Asafrani*** was traditionally cultivated in irrigated gardens by women who used it to color their ***piki*** bread. Several older women interviewed had grown this in the past or recalled their mothers growing it. They described going to the garden in the morning to harvest flower heads, and removing the yellow petals which were dried and then ground into a yellow powder. When added to white cornmeal batter it makes yellow ***piki.*** Today commercial food dye is used instead. No one interviewed grows ***asafrani*** anymore, nor did they know of anyone growing it. It was mentioned that Moenkopi is the only place where it still might be found; however, none of the farmers interviewed for this survey in Upper or Lower Moenkopi reported growing ***asafrani.***

Red amaranth or ***komo*** *(Amaranthus cruentus)* was another traditional ***piki*** colorant also grown in irrigated gardens. *A. cruentus* is thought by some to be native to central and northern Arizona (NRC 1984:3), but the history of its use by the Hopi is not known. Whiting (1939:75) describes it as an introduced crop, whose red inflorescence was used to color ***piki*** a bright pink.

Many women and some men knew about ***komo,*** far more than knew about ***asafrani.*** No one interviewed was growing ***komo*** but two farmers said they have it volunteering in their fields. A few women said they saw some ***komo*** growing in a Hotevilla garden not long ago, but none was observed while conducting this survey.

Black seeded sunflowers (***tceqa'a,*** *Helianthus annuus*) are a traditional Hopi FV whose black hulls produce a purple or black dye. Three people also described making a poultice from the hulls and/or seeds to use for eye medicine. Heiser (1945:165) noted that the hypocotyl of the black seeded Hopi sunflower "elongates much more rapidly" than in the common commercial Mammoth Russian variety, possibly representing an adaptation to the Hopi growing environment similar to that of the corn as described by Collins (1914a, 1914b). Only four interviewees said they still grow these sunflowers (two others said the sunflowers volunteer in their fields); however, there was great interest in acquiring the seeds. Perhaps the growing production of baskets for sale to tourists plays a role in this, especially as those buyers may be requesting "natural" or "traditional" craftwork.

*Fruit trees.*—There is concern about the decline and death of many of the old peach trees growing near the villages. Many old orchards consisting primarily of peaches and some apricots have been or are being abandoned. Competition from weeds for scarce soil moisture, broken, unpruned limbs, and roots exposed by wind erosion are the consequences of the neglect of these orchards, and can result in dead trees.

Although new varieties are available and being tried by Hopi households, some people we spoke with said that Hopi peach varieties produce sweeter fruit and are longer-lived and more drought resistant than commercial varieties. Several farmers described the continuing practice of starting Hopi peach and apricot trees from seed. The one problem noted with this technique is that it is relatively slow, especially when transplants several years old can be purchased in nearby towns.

## CONCLUSION

Because ours was a nonprobability sample, it is not valid to extrapolate the results to Hopi farmers in general. Rather, we can suggest several hypotheses about Hopi crop diversity and change in general, based on the results of our survey, on other information available on the Hopi discussed above, and to some extent on a limited comparison with the 1935 survey. The general hypothesis is that while experimentation with new varieties appears to be constant in Hopi agriculture, the fate of each FV will depend on the unique combination of the biophysical and sociocultural selection environment of that FV. Below we present four more specific hypotheses illustrated with examples. The practical meanings of these hypotheses are well understood by many Hopi farmers, and it is they who should decide whether any further research to test them is appropriate.

(1) The biophysical environment. FVs will tend to be lost when changes in the local biophysical environment reduce the importance of the FVs' adaptation. FVs will tend to be retained when the biophysical environment remains the same, or

changes in ways that increase the importance of the FVs' adaptation. Water is a limiting factor for crop production in the Hopi environment. Where irrigation water is available it creates a controlled growing environment amenable to many crops and varieties, including MVs. For example, a much lower proportion of FVs are grown in the irrigated gardens than in rain-fed fields, and much more commercial sweet corn is grown in irrigated fields at Moenkopi than in the rain-fed fields elsewhere. Farmers frequently mentioned ecological differences between Hopi and non-Hopi varieties, and evidence exists for drought adapted root characteristics in Hopi corn and sunflower FVs.

(2) Sociocultural environment. FVs will tend to be lost when sociocultural changes, including acculturation, reduce the importance of their adaptation, especially when they do not have a central role in society and culture. FVs will tend to be retained when their role in culture and society is important, as with older crops such as beans and especially corn which are central in Hopi religion. It was common for farmers we interviewed to point out the importance of growing those varieties said to be given to the Hopi by their Creator. The introduction of grinding diminished the desirability of the softer blue corn ***(maasiquaë),*** while the cash economy reduced the desirability of the harder blue corns, since storing two years' harvest against harvest failure was no longer necessary. It may be that both of these factors helped lead to the partial collapse of blue corn varieties. In this example, blue corn is retained because it meets environmental conditions (drought, short season) and cultural requirements (for blue colored corn important in religious ceremonies), but different varieties of blue corn are being lost because the importance of their unique postharvest characteristics is much diminished by social changes. Hopi tepary bean FVs may be being lost because social changes mean that people no longer have the time to spend in the field protecting them from predators.

When biophysical and sociocultural changes make possible the replacement of FVs, two other factors determine the fate of FVs in farmers' repertoires:

(3) Availability of seeds. FVs will tend to be lost when seed of new varieties that are similar (including MVs) become available, as with sweet corn, where widespread availability of commercial seed has been associated with a decrease in Hopi farmers growing Hopi sweetcorn FVs. There are increasing opportunities for Hopis to buy seeds of non-Hopi varieties that are similar to Hopi FVs. For example, the larger proportion of farmers in 1989 growing commercial varieties of red vs. yellow watermelon may reflect differences in seed availability. However, while seed for blue corn or blue corn food products have not been commercially available until recently, white corn seed and food products have been available for some time, and yet the Hopi white corn FV has been retained, supporting the idea that availability of seeds is not the only important factor in the retention of corn FVs. Many farmers mentioned the availability of pinto beans for food (and seed) as a reason for not growing them. Pintos are an historic introduction and are not as important in Hopi culture as other bean FVs.

(4) Availability of alternative products. FVs will tend to lost when alternative products become available. For example, the dye plants safflower and red amaranth, used to color ***piki*** bread and other products, were lost when cheap commercial food dyes became available. The keeping qualities of Hopi watermelon FVs may

no longer be a factor favoring their retention when watermelon or other fruits are available in stores year-round.

As the importance of stability and diversity for the sustainability of agriculture becomes more widely accepted, the ability of FVs to produce relatively stable yields with low inputs in the local environments in which they have been selected may also become more important. This could lead to increasing respect for diverse local cultural groups and their knowledge about creating and maintaining crop genetic diversity. The Hopi people today live in the midst of the United States, one of the nations most committed to the industrialization of agriculture, including the use of MVs. Their retention of a large proportion of their FVs may therefore hold important lessons for the maintenance of crop genetic diversity. Conservation of this diversity may best be accomplished in the long run by ensuring its survival *in situ* as part of local farming communities like the Hopi.

## NOTES

[1]Total farmers equals 45 because ages of five farmers were not estimated.

[2]Spelling of Hopi words in this paper is based on Albert and Shaul (1985), or when not found in that reference, on Whiting (1939).

[3]The original notes are at the University of Michigan, Museum of Anthropology, Ann Arbor, MI 48109-1079, and we obtained copies from the Director, Richard I. Ford. There are a total of 59 survey records of 1–2 pages each; 56 surveys of Hopi and 3 of Navajo farmers. Their survey included "all of the households" in Shipaulovi and "typical families" from all of the other villages, including Moenkopi (Whiting 1935:2). Only data from 46 were reported, however, "the others being considered unsuitable for this purpose" (Whiting 1937:13). No basis is given for eliminating the other 10 surveys. They established their headquarters in October and made a collection of the crop plants "which were mature at that season" (Whiting 1935:1). It is not clear what relation the specimens had to the interviews about seed sources, since Whiting states that "in addition to the actual collection of crop specimens a survey was taken of over fifty households" (Whiting 1935:2). It appears as though Nequatewa, a Hopi who worked at the Museum of Northern Arizona, did most of the actual field work, as Whiting writes that he "could be depended on to carry on the investigation in the homes of his own people without the ever constant disturbing element of two, somewhat eccentric white ethnologists" (Whiting 1935:1). No other information is available on the methods used in the 1935 survey.

[4]We used 55 of Whiting's 56 Hopi survey forms. We eliminated one because it was based on the entire farming career of a man who no longer farmed, while the other surveys apparently contain information only for seeds of crops harvested in 1935.

[5]Bruce Butterfield is the director of research for the National Gardening Association in Burlington, Vermont. Each year they publish the National Gardening Survey based on research by the Gallup Organization. Every fifth year this includes information on crop varieties grown.

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Gary P. Nabhan at Native Seeds/SEARCH (NS/S) first had the idea for research on changing Hopi crop repertoires and acquired the funding for this research. He also conducted the interviews at Upper and Lower Moenkopi. We carried out this research as employees of NS/S. Other NS/S staff made this work easier with their assistance in preparing seed orders, discussing crop varieties, and the financial management of this project. We thank the editor, Deborah Pearsall and the reviewers for the *Journal of Ethnobiology* (Stephen Brush and one anonymous reviewer) for their comments on a draft of this article. Thanks to José Luna-Ruiz for the Spanish and Kebe Brahim for the French translations of the abstract.

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# BOOK REVIEW

**Medicinal Plants: New Vistas of Research (Parts I and II).** V.K. Singh and Shamima Hashmi (editors). Volumes X and XI of series, **Glimpses in Plant Research** (series editor, J.N. Govil). New Delhi, India: Today & Tomorrow's Printers and Publishers (24 B/5, Desh Bandhu Gupta Road, Karolbagh, New Delhi 110005), 1993. Part I-Pp. xi, 286. $59.00 U.S. !SBN 1–55528–272–5 (U.S.A.), 81–7019–417–2 (India). Part II-Pp. xi, 287-570. $59.00 U.S. ISBN 1–55528–273–3 (U.S.A.), 81–7019–418–0 (India).

The recent resurgence of interest in medicinal plants research is adequately supported by the material set forth in the present work. The publication has contributions by many experts from India and abroad on various aspects of medicinal plants and provides recent data concerning: (a) Ethnobotany: folk medicines used by tribals and rural population including preliminary clinical trials; (b) Pharmacognostic studies of traditional drugs; (c) Experimental cultivation and economics of commercially important drugs; (d) Biochemistry and biotechnology of plant products; (e) Botanical identification and standardization of drugs; (f) Cytogenetics, microbiology and biological control; (h) Environment and pollution studies.

There is an author and subject index; and also index of botanical binomials in each volume.

These volumes amply exhibit the outstanding interest and research that is current in India. The editors of this work are amongst those who are making India one of the outstanding countries in research into traditional medicine and the practical results that may follow scientific research from the chemical and pharmacological study of the medical plants of tribal peoples. Dr. Vinay Kumar Singh is Scientist-in-charge of the Survey of Medicinal Plants Unit of the Regional Research Institute of Unani Medicine (Central Council for Research in Unani Medicine, New Delhi), a taxonomist, economic botanist and ethnobotanist; he has been the recipient of several prestigious awards. Dr. (Ms.) Shamima Hashmi, a plant anatomist working as pharmacognosist in the capacity of Research Officer, is the author of 40 pharmacognistic papers. Dr. J.N. Govil (General Editor of the series), a geneticist, is currently working in the Agricultural Research Institute of New Delhi; he is the author of 70 research papers. It is a pleasure and an honour for me to salute these scientists for gathering and editing such a diversity of technical papers in one volume. It is another indication of the intensity of interest in ethnopharmacology in India—a fact that the rest of the world with ethnobotanical outlooks admires.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

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# PLANT USES IN A BRAZILIAN COASTAL FISHING COMMUNITY (BÚZIOS ISLAND)

A. BEGOSSI
*Núcleo de Estudos e Pesquisas Ambientais*
*Universidade Estadual de Campinas*
*CP 6166*
*Campinas, SP, 13081–970, Brazil.*

H.F. LEITÃO-FILHO
*Departamento de Botânica e Parque Ecológico*
*Universidade Estadual de Campinas*
*Campinas, SP, 13081–970, Brazil.*

P.J. RICHERSON
*Division of Environmental Studies*
*University of California*
*Davis, CA 95616, USA.*

ABSTRACT.—Búzios Island (southeast Brazil) is a fishing community in which agriculture played an important role in the past. Despite the increased importance of market-oriented fishing, decline of agriculture, and shift from traditional herbal toward modern medicine, wild and cultivated plants still play a major role in the economics of the community. This study gives a general description of vegetation, cultivated or collected plants used for food, construction, handicrafts, and medicinal purposes. Local and scientific names are provided for 61 plants used for food, 53 plants used in medicine, and 32 species used for house and canoe construction and handicrafts. On Búzios, older adults showed a better knowledge of medicinal plants than younger ones. Many medicinal plants are used for the treatment of worms, which are common among children. The medicinal plants used on Búzios Island are widespread plants commonly used in other parts of Brazil. We found a high diversity of plants used on Búzios even compared to Amazonian communities.

RESUMO.—A comunidade pesqueira da Ilha dos Búzios (sudeste do Brasil), teve no passado a agricultura como atividade predominante. Apesar do desenvolvimento das atividades de pesca, do decréscimo da agricultura e de certa mudança da medicina caseira para uma mais moderna, as plantas coletadas e cultivadas ainda tem um papel importante na economia da comunidade. Este estudo apresenta uma descrição geral da vegetação da área, das plantas cultivadas ou coletadas para alimentação, construções, artesanato e para usos medicinais. Nomes locais e científicos são listados para 61 plantas usadas como alimento, 53 usadas na medicina caseira e 32 usadas em construções de casas e canoas, e para artesanato. Em Búzios, os indivíduos mais velhos demonstraram um conhecimento maior sobre plantas medicinais. Muitas dessas plantas são usadas no tratamento de verminoses, muito comuns entre as crianças. As plantas medicinais usadas em Búzios são também usadas em outras partes do Brasil. Encontramos em Búzios

uma alta diversidade de plantas usadas, mesmo comparada à de comunidades da Amazônia.

RÉSUMÉ.—La communauté de pêcheurs de l'île de Búzios (située au sudest du Brésil) pratiquait, dans le temps, l'agriculture comme une des activités prédominantes. Malgré le developpement de la pêche, la diminution de l'agriculture, et un certain changement de la médecine ménagère envers une plus moderne, les plantes cultivées et récoltées jouent encore un rôle important dans l'économie de la communautée. Cette étude présente une description générale de la végétation de l'endroit, des plantes cultivées ou récoltées en vue de leur utilisation dans l'alimentation, la construction, l'artisanat, et l'usage médicinal. Ont été catalogués les noms locaux et les noms scientifiques de 61 plantes utilisées dans l'alimentation, 53 utilisées en médecine ménagére, et 32 pour la construction des maisons et des canöes, ainsi que l'artisanat. A Búzios, les personnes plus agées ont démontré une connaissance plus profonde des plantes médicinales. Un grand nombre de ces plantes s'emploie à soigner la verminose, très fréquente parmi les enfants. Les plantes médicinales utilisées à Búzios sont aussi employées dans d'autres régions du Brésil. On trouve à Búzios une grande diversité de plantes utilisées localement; cela, même comparé aux communautés de la région Amazonique.

## INTRODUCTION

Ethnobotanical studies have shown that humans have discovered and improved plants for a variety of purposes, including food, shelter, and medicine. Even in the case of medicine, where modern inventions appear to dominate, we owe a great debt to folk medicine for a knowledge of the healing properties of plants (Schultes 1978). Many aboriginal cultures in Africa, Asia, and South America are disappearing; there is a danger that much of potentially useful knowledge of the curative properties and other uses of plants will vanish with these cultures. Even in industrialized countries, 45% of commercial drug production comes from natural products (Elisabetsky 1986). There is less comment in the literature on the effects of modernization on nonmedicinal plant uses. Similarly, the continued use of land for cultivation and plant communities for collected resources by modernizing communities is an important issue in conservation biology. Several aspects of the Búzios Island economy and society have changed significantly since the careful field study conducted by Willems in 1947 (Willems 1952). This offers us an unusual opportunity to document changes and continuities in plant use as a function of modernization.

This study is part of a larger research project in human ecology carried out at Búzios Island (Begossi 1989) that included an analysis of all economic and subsistence activities. Fish and terrestrial plants play a dominant role in islanders' subsistence and commercial production. We describe here the plants used by families from Búzios, and present an analysis of the current relationship between agriculture and fishing.

In spite of an economic shift at Búzios from farming to fishing during the course of the twentieth century (Begossi 1989), plants are still very important to islanders' livelihoods. Plants are cultivated and collected on Búzios for a variety of purposes, such as medicine, house construction, handicrafts, and food. The economic shift on Búzios is similar to events along the whole northern coast of

São Paulo State. According to Diegues (1983), the shift from agriculture to fishing that occurred mainly since the 1950s is due to low prices for agricultural products relative to fish, and to accumulating soil and pest problems in the agricultural sector.

One of the first studies of Brazilian plant utilization (including medical practices and Portuguese and Indian influences) was that of Piso in 1648 (Piso 1957). As pointed out by Lévi-Strauss (1986), few peoples have so complex a knowledge of the physical and chemical properties of plants as do the South American Indians. Prance et al. (1987) studied the plant utilization of four South American Indian groups and showed that 49–79% of the tree species on one hectare sample forest plots were useful to each group. They suggest that such a high usage has important implications for conservation policies.

Búzios Island is in the heavily disturbed Atlantic Forest Phytogeographic Province. It would be interesting to know to what extent studies from other parts of Brazil, especially from Amazonia, can be applied to this region. Southeast coastal populations, called *caiçaras,* are influenced by Portuguese and Indian culture; Indian influences are still conspicuous in manioc flour processing, for example.

## THE STUDY SITE

Búzios Island is located in southeastern Brazil (23° 47′ S, 45° 10′ W), off the coast of São Paulo State (Fig. 1). The population of the island consists of about 220 individuals (44 families) distributed among 8 hamlets situated on small harbors with canoe shelters. Porto do Meio is the largest harbor, with 23 families. Bairro de São Francisco (São Sebastião City) and Ilhabela (São Sebastião Island) are the main urban localities visited by islanders.

Leitão-Filho (1982, 1987) and Silva and Leitão-Filho (1982) give descriptions of the Atlantic Forest of São Paulo State. Ecologically important families and genera are: Myrtaceae *(Eugenia, Myrcia, Marlierea),* Sapotaceae *(Pouteria, Chrysophyllum),* Lauraceae *(Ocotea, Nectandra, Aniba),* Euphorbiaceae *(Hyeronima, Croton, Alchornea, Pera),* Elaeocarpaceae *(Sloanea),* Mimosaceae *(Inga, Pithecellobium, Piptadenia),* Fabaceae *(Centrolobium, Andira, Hymenolobium),* and Caesalpiniaceae *(Sclerolobium, Tachigalia).* In areas deforested (either by fire or by cutting), the predominant plants are shrubs and colonizing plants from the genera *Tibouchina, Piper, Costus, Rapanea, Leandra, Trema, Cecropia,* and *Solanum,* typical of early successional stages of the Atlantic Forest.

Forests on Búzios Island are found on top of the main hill of the island and on the uninhabited side (Figs. 1 and 2). Fruit trees, such as mango *(manga)* (*Mangifera indica* L.) and jack fruit *(jaca)* (*Artocarpus integrifolia* L.) are planted next to houses, especially at the harbors of Guanxuma and Pitangueira. Porto do Meio, the most populous harbor, has proportionately fewer trees and more grassland.

## METHODS

One of us (AB) carried out field work on Búzios Island from September 1986 to December 1987. Observations and photographs of plant utilization by community members for agriculture, construction, and medicinal purposes were obtained

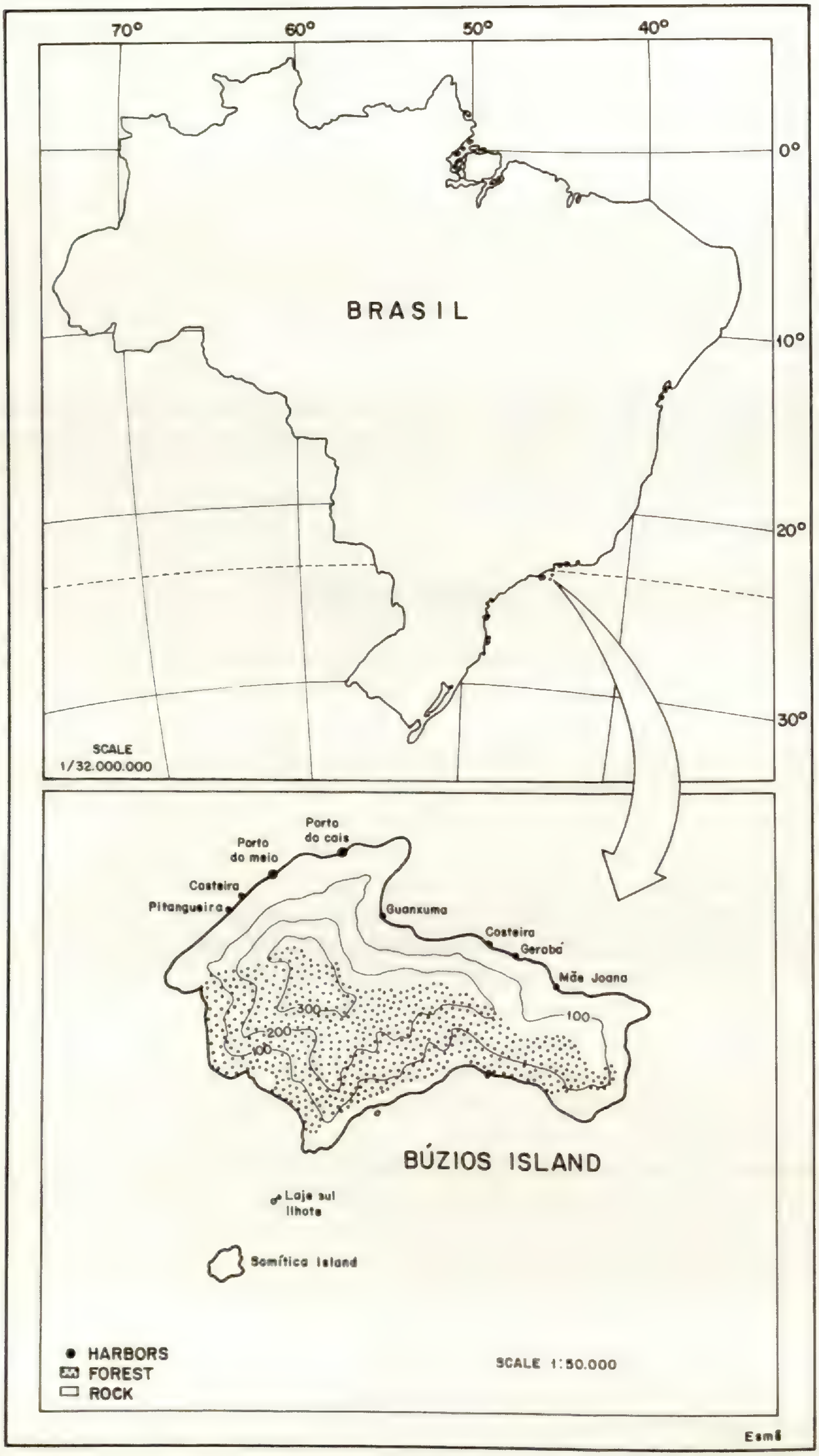


FIG. 1.—Location of Búzios Island in Brazil and the distribution of harbors.

FIG. 2.—General view of Búzios Island.

mainly at Porto do Meio Harbor. Plant collections and interviews were made at all harbors except Mãe Joana, Costeira, and Gerobá, where seven families lived (Fig. 1). These harbors were difficult to reach as the island topography is quite dissected and weather and rough seas often prevent canoe travel. Twenty-eight families (adults) were interviewed concerning utilization of medicinal plants in February 1987. In general, both husband and wife participated in interviews. The names of plants collected for identification were checked with informants from Porto do Meio. Plants were identified at the Herbarium of the Universidade Estadual de Campinas (UEC) at Campinas, São Paulo, Brazil.[1] Small birds were identified by L.O.M. Machado, J. Vielliard, and O.C. de Oliveira of the Departamento de Zoologia, Universidade Estadual de Campinas, São Paulo, Brazil.

## SHIFT FROM AGRICULTURE TO FISHING

França (1954) reviewed the general history of agriculture for the northern coast of São Paulo, and his generalizations provide the context in which the Búzios economy developed. Before 1800 the coast of São Paulo, in particular São Sebastião Island, was economically dominated by sugarcane plantations where sugar and sugarcane rum (*aguardente* or *pinga*), a typical Brazilian beverage, were produced. Around 1800 coffee plantations began to replace sugarcane. Coffee plantings peaked in the midnineteenth century and the industry collapsed in the decade after 1870. During the first half of this century, cultivation of sugarcane (this time restricted to the production of *aguardente*) was again the main economic activity, but declined gradually toward midcentury. Manioc had been always a staple crop, despite these introductions.

On Búzios today, agricultural activities are still carried out mainly for subsistence. Cash income is obtained almost exclusively from fish sales (Begossi 1989). But agriculture centered around the cultivation of manioc was formerly more important in the local economy. Willems (1952) reported that during his stay at Búzios, 33 men worked at farming as their major activity while only two depended primarily on fishing. According to older informants, at the beginning of this century Búzios islanders cultivated rice, beans, maize, manioc, cotton, coffee, and oranges, and even exported some of these crops. These crops, along with sweet potatoes, yams, *attas,* pumpkins, sugarcane, coconuts, bananas, and tobacco were mentioned by Willems (1952). As is the case with contemporary Búzios, manioc, sweet potatoes, and sugarcane were important crops in the past, but Búzios was never a self-sufficient community. In spite of a stable subsistence based on manioc and fish, major changes occurred in commercial production on the island; starting with coffee in the last century, the island's economy moved from trade of salted fish and black beans, to cultivation of manioc and beans and algae collecting (Willems 1952), and finally back to trade of fish. Agriculture has thus been replaced on Búzios by fishing as the principal economic activity. Fishing is especially emphasized by younger people. Older islanders still maintain manioc and bean fields, and are usually part-time rather than full-time fishermen.

Búzios is similar to other relatively small and isolated settlements in which social relations are based on kinship ties (Begossi 1989). Products are exchanged along family lines, and there is an informal division of labor in that younger fishermen exchange fish for plant foods grown and collected by their older relatives.

## CONTEMPORARY AGRICULTURAL PRODUCTION

Beans and potatoes are important in contemporary diets, but are now largely purchased on the coast. Manioc continues to be a basic staple crop on Búzios Island but it is commercialized by a few families, especially when fishing is not possible.

*Roças* (swiddens) are small plots located five to ten minutes, by foot, from the houses; *hortas* are small gardens next to the houses where green vegetables are grown (Fig. 3). About 17 species of fruit trees are planted by islanders and along with other crops they represent a greater diversity of products than described by Willems (1952) (Tables 1 and 2).

*Roças* are prepared for planting by clearing the plot with axes, machetes, and hoes, and burning the resulting debris. Plots are prepared and planted in the dry season, from July to October. The bean harvest occurs three or four months later, whereas manioc is harvested throughout the year. After two or three years the plot can be burned again or left fallow. Informants told us that they may use the same plot for five or six years. The decision either to continue cultivating or to leave a given plot fallow is based on expected *roça* productivity. Fields that are still producing a reasonable crop of large manioc tubers are burned again.

Production of manioc flour occurs in a separate building next to the house that is called the *casa de farinha* (flour house). The technique and instruments used to process manioc are indigenous and the same as Willems (1952) described. The time spent on each step in the processing of manioc and the production of flour was recorded by Begossi (1989:62). Two persons need about one day to produce

FIG. 3.—(a) a typical *roça* with beans and bananas; (b) a garden *(horta)* protected by pieces of fishing nets.

TABLE 1.—Field *(roças)* and garden *(hortas)* food crops cultivated at Búzios Island. Fields are small plots located in walking distance (5–10 minutes) from residences while the gardens are located next to houses. Portuguese names are the ones used at Búzios. Plants from Brazil are considered as native (n) while plants from other areas (including South America) are considered as exotic (e).

| Plant Names | | |
|---|---|---|
| Common Name | Scientific Name | Family |
| **In Open Fields** *(roça)* | | |
| e *batata* potato | *Solanum tuberosum* L. | Solanaceae |
| e *batata doce* sweet potato | *Ipomoea batatas* Poir. | Convolvulaceae |
| e *cana de açucar*[1] sugarcane | *Saccharum officinarum* L. | Gramineae |
| e *cará (inhame)* yam | *Dioscorea alata* L. | Dioscoreaceae |
| e *café*[2] coffee | *Coffea arabica* L. | Rubiaceae |
| e *feijão*[3] beans | *Phaseolus vulgaris* L. | Fabaceae |
| e *feijão guando* red gram | *Cajanus cajan* (L.) Mill. | Fabaceae |
| e *feijão fava* | *Phaseolus lunatus* L. | Fabaceae |
| n *mandioca*[4] *(rama)* manioc | *Manihot esculenta* Crantz. | Euphorbiaceae |
| n *mandioca landí-preto* manioc | *Manihot* sp.1 | |
| n *mandioca vermelhinha* manioc | *Manihot* sp.2 | |
| n *mandioca landí-miúdo* manioc | no longer used | |
| n *mandioca macaé* manioc | no longer used | |
| n *mandioca maria francisca* manioc | no longer used | |
| n *mandioca saracura* manioc | no longer used | |
| e *milho* maize | *Zea mays* L. | Gramineae |
| e *soja* soybean | *Glycine max* (L.) Merr. | Fabaceae |
| **In House Garden** *(horta)* | | |
| e *abóbora* squash | *Cucurbita pepo* L. | Cucurbitaceae |
| e *abobrinha* summer squash | *Cucurbita pepo* L. | Cucurbitaceae |
| e *alface* lettuce | *Lactuca sativa* L. | Compositae |

| Plant Names Common Name | Scientific Name | Family |
|---|---|---|
| e *almeirão* blue sailors | *Cichorium endivia* L. | Compositae |
| e *cebolinha* welsh onion | *Allium fistulosum* L. | Liliaceae |
| e *chicória* chicory | *Cichorium intybus* L. | Compositae |
| e *chuchu* chocho | *Sechium edule* Sw. | Cucurbitaceae |
| e *couve* cole | *Brassica oleracea* L. | Cruciferae |
| e *pepino* cucumber | *Cucumis sativus* L. | Cucurbitaceae |
| e *pimentão* green pepper | *Capsicum annuum* L. | Solanaceae |
| n *pimenta vermelha* hot pepper | *Capsicum frutescens* L. | Solanaceae |
| e *quiabo* okra | *Hibiscus esculentum* L. | Malvaceae |
| e *repolho* cabbage | *Brassica oleracea* L. | Cruciferae |
| e *salsinha* parsley | *Petroselium sativum* L. | Umbelliferae |
| e *tomate* tomato | *Lycopersicum esculentum* Mill. | Solanaceae |

[1]eaten by children; they also make *garapa* (fresh sugar cane juice) to drink and as a substitute for refined sugar.

[2]one family

[3]varieties of *Phaseolus vulgaris* are: *bico de ouro, carioca,* or *listradinho da roça* and *roxinho.*

[4]varieties of *Manihot esculenta* are: *branca, doce, nortista, vassourinha,* and *roxinha da areia.*

one *alqueire* (standard weight measure used at the island, equal to 22 kg) of manioc flour, using the steps shown in Fig. 4. On average, one person-hour of labor yields about 1 kg of manioc flour. Manioc prices are low compared to the price of fish in the markets of Ilhabela or Bairro de São Francisco. For example, the price of manioc flour was 10 cruzados/kg (US$ 0.23) in June, 1987. Fishing was much more rewarding per unit of effort. In the same month, a very inexpensive fish such as yellow chub [(*Kyphosus incisor* (Cuvier)] was sold by islanders for 10 cruzados/kg while an expensive fish such as grouper (Serranidae) brought 25 cruzados/kg. Typical fish catches yielded approximately 3 kg per trip and trips lasted around two hours. Thus fishing was minimally 1.5 times as productive per unit of labor as manioc processing, without including the labor of growing manioc (for more information on the economics of fishing see Begossi 1989 and Begossi and Richerson 1991).

TABLE 2.—Fruits cultivated and collected (*) for food at Búzios Island. Portuguese names are the ones used at Búzios. Native (n) and exotic (e) species.

| | Plant Names Common Name | Scientific | Family | Voucher Number (AB, UEC) |
|---|---|---|---|---|
| e | *abacate* avocado | *Persea americana* Mill. | Lauraceae | |
| n | *abricó* mamey apple | *Mammea americana* L. | Guttiferae | 10812 |
| e | *amora** raspberry | *Rubus rosaefolius* Sm. | Rosaceae | 23906 |
| n | *azedinha** | *Oxalis hedisarifolia* Raddi | Oxalidaceae | 49815 |
| n | *araçá* | *Psidium cattleyanum* Sabine | Myrtaceae | 12227 |
| n | *bacuparí** | *Rheedia gardneriana* Planch. *et* Triana | Clusiaceae | 5524 |
| e | *banana* banana | *Musa acuminata* Colla | Musaceae | |
| e | *chapéu de sol** tropical almond | *Terminalia catappa* L. | Combretaceae | 1435 |
| e | *coco* coconut | *Cocos nucifera* L. | Palmae | |
| n | *coquinho** | *Syagrus* sp. | Palmae | |
| e | *Feijão guando*[1] red gram | *Cajanus cajan* (L.) Mill. | Fabaceae | |
| e | *fruta do conde* sugar apple | *Annona squamosa* L. | Annonaceae | |
| n | *goiaba branca* guava | *Psidium guajava* L. | Myrtaceae | |
| n | *guapeba** | *Pouteria* sp. | Sapotaceae | |
| n | *ingá** inga | *Inga sessilis* (Vell.) Mart. | Mimosaceae | 49737 |
| e | *jaca* jack fruit | *Artocarpus integrifolia* L. | Moraceae | |
| e | *jambolão* jambolan | *Eugenia cumini* (L.) Druce | Myrtaceae | |
| e | *jambro*[2] star apple | *Syzygium jambos* (L.) Alston | Myrtaceae | 47000 |
| e | *laranja*[3] orange | *Citrus sinensis* (L.) Osbeck | Rutaceae | |
| e | *limão* lemon | *Citrus aurantifolia* Swing. | Rutaceae | |
| e | *mamão* papaya | *Carica papaya* L. | Caricaceae | |
| e | *melão de São Caetano** | *Momordica charantia* L. | Cucurbitaceae | 33276 |
| e | *mexerica** | *Clidemia hirta* D. Don. | Melastomataceae | 10342 |
| e | *manga* mango | *Mangifera indica* L. | Anacardiaceae | |

| | Plant Names Common Name | Scientific | Family | Voucher Number (AB, UEC) |
|---|---|---|---|---|
| n | *maracujá (imbucuiá)* passion fruit | *Passiflora edulis* Sims. | Passifloraceae | 12714 |
| n | *paina** silk cotton tree | *Pseudobombax grandiflorum* (Cav.) A. Robyns | Bombacaceae | 949 |
| n | *pitanga** Brazilian cherry | *Eugenia uniflora* L. | Myrtaceae | 11745 |
| e | *romã* pomegranate | *Punica granatum* L. | Punicaceae | |
| e | *uva* grape | *Vitis vinifera* L. | Vitaceae | |

[1]children eat the green seeds

[2]children eat the flowers, too.

[3]variety called serra d'água

## PLANTS USED FOR FOOD, CONSTRUCTION, AND MEDICINE

Plants consumed at Búzios are listed in Tables 1 and 2. Fruits are often collected by children; these include mangos, *Momordica charantia* L. *(melão de São Caetano),* tropical almond *(chapéu de sol)* (*Terminalia catappa* L.), inga (*Inga sessilis* [Vell.] Mart.), *Pouteria* sp. *(guapeba), Syagrus* sp. *(coquinho),* and *Oxalis hedysarifolia* Raddi *(azedinha).* Other plants are used to spice foods; these include two Labiatae, basil *(fabaca)* (*Ocimum gratissimum* L.), used on shark, and *Coleus* sp. *(hortelã de galinha),* used on chicken. Arrowroot *(caiquê)* (*Maranta* sp., Marantaceae) is used to cover *pamonha,* a kind of cake made with corn paste. Two wild plants, palm *(palmito)* (*Euterpe edulis* Mart., Palmae, AB 40913, UEC) and primrose malanga *(taioba)* (*Xanthosoma violaceum* Schott, Araceae, AB 23604, UEC), are appreciated as food.

Fruits of Brazilian peppertree *(aroeira)* (*Schinus terebinthifolius* Raddi, AB 37703, UEC) are put in traps made of yellow bamboo *(taquaruçú)* (*Bambusa* sp.) to catch saddle tanager *(tiê-sangue)* (*Rhamphocelus bresilius* Sclater) and thrushes *(sabiá)* (*Platicychla flavipes* Vieillot, *Turdus* spp.), usually eaten with beans. At Pitangueira Harbor, where 5 families live, islanders told us they caught about 130 birds in May and June, 1987. Birds are a dietary supplement when fishing is either impossible or has low returns, such as in the windy days of winter.

The bark of meadow beauty *(jacarterão)* (*Miconia* sp.) is used in net staining. Lenko (1965) also reported the use of Brazilian peppertree and meadow beauty for this purpose. Handicrafts, such as model canoes and wooden spoons, are made with silk-cotton tree *(paina)* (*Pseudobombax grandiflorum* [Cav.] A. Robyns) and *Malouetia arborea* Miers *(guaranda),* among other species. Woody lianas *(imberanda)* (*Philodendrum guttiferum* Kunth), bamboo *(taquara)* (*Merostachys* sp.), and

FIG. 4.—Main steps in the production of manioc flour: (a) peeling manioc, (b) grinding manioc using an arm-wheel (*roda de braço*), (c) pressing manioc using the *arataca;* on left are baskets called *tipití,* (d) manioc being toasted in a wood-burning copper furnace.

FIG. 5.—Handicrafts made by islanders.

yellow bamboo *(taquaruçú)* (*Bambusa* sp.) are used to make baskets, hats, and fish models that islanders sell at Ilhabela (Table 3 and Fig. 5).

Necklaces and curtains are made with seeds of Job's tears *(capiá)* (*Coix lacryma-jobi* L., Gramineae, AB 16865, UEC). Cattail *(taboa)* (*Typha angustifolia* L., Typhaceae, AB 17457, UEC) is used to make mats *(esteiras)* and the flowers of *Achyrocline satureoides* DC. (Compositae, AB 49444, UEC) *(macela)* are used to stuff pillows. *Baccharis dracunculifolia* DC. (Compositae) (AB 25968, UEC), *Malvastrum coromandellianum* (L.) Gurcke (AB 40296, UEC) and *Sida spinosa* L. (AB 10186, UEC) (Malvaceae), locally called *vassourinha*, are bundled to make brooms. *Vriesia* sp. *(caraguatá)*, a Bromeliaceae, is used as a lure for bluefish [(*Pomatomus saltator* (L.)], bluerunner [*Caranx crysos* (Mitchill)], and species of Scombridae.

About ten plants used in house construction and for handicrafts, among other uses, were listed by Willems (1952). Some are still used at Búzios, such as woody lianas, grass for roofs, cattail for mats, and a Bromeliaceae for bait. There were about thirteen plants (names not listed in Willems 1952) used for dugout canoes, but we found only seven species used for this purpose (Table 3). Islanders from Porto do Meio complained that good trees for canoes are hard to find close by, and that the forest was becoming "far away from home," suggesting a relatively intensive use of resources through the years.

Dugout canoes are built in the forest from a single trunk of a large tree. There were some 22 finished paddled canoes at Porto do Meio; during September 1987, three canoes were built from *aracurana* (*Alchornea iricurana* Casar) logs. Two were built by three fishermen who spent 18 working days on the task (10 in the forest and 8 at home). We observed the heavy work involved in the transportation of

TABLE 3.—Plants used at Búzios Island for canoe, house, and dock construction and for handicrafts. A = handicrafts such as baskets and *tipití;* C = canoes; D = wood for docks or foot bridges on which canoes roll; H = framing for houses; P = paddles; R = roofs; W = wooden handicrafts such as small canoes and wooden spoons; and N = uses not specified. Native (n) and exotic (e) species.

| Plant Names Common | Scientific | Family | Uses | Voucher Number (AB, UEC) |
|---|---|---|---|---|
| ? *aia* | ? | ? | N | |
| n *angelim* anjelywood | *Jacaranda* sp. | Bignoniaceae | CDP | |
| n *araçá* | *Psidium cattleyanum* Sabine | Myrtaceae | D | 32875 |
| n *aracurana*[1] (urucurana) | *Alchornea iricurana* Casar | Euphorbiaceae | C | 4567 |
| n *bucuíba* (mucuíba) | *Virola oleifera* (Schott) A.C. Smith | Myristicaceae | C | 11549 |
| n *cafeeiro* do mato | *Cordia* sp.1 | Boraginaceae | D | |
| n *caixeta* trumpet tree | *Tabebuia cassinoides* D.C. | Bignoniaceae | P | 37862 |
| n *canela* cinnamon | *Ocotea* sp. | Lauraceae | D | |
| n *capororoca* | *Rapanea lancifolia* Mez | Myrsinaceae | DP | 11587 |
| n *capororoca-uçú* | *Rapanea umbellata* Mez | Myrsinaceae | D | 40335 |
| n *cedro* tropical cedar | *Cedrela fissilis* Vell. | Meliaceae | CW | 40282 |
| e *chapéu de sol* tropical almond | *Terminalia catappa* L. | Combretaceae | D | 1435 |
| n *cubatã* | *Cupania racemosa* (Vell.)Radlk. | Sapindaceae | DH | 14320 |
| n *figueira* fig tree | *Ficus* sp. | Moraceae | C | |
| n *guaranda* | *Malouetia arborea* Miers | Apocynaceae | DW | 20898 |
| n *guatambú* | *Guettarda* sp. | Rubiaceae | N | |
| n *guatiguaba* | *Trichilia* sp. | Meliaceae | N | |
| n *imberanda* | *Philodendrum guttiferum* Kunth | Araceae | A | 7818 |
| n *ingá* inga | *Inga sessilis* (Vell.) Mart. | Mimosaceae | C | 49737 |
| n *ipê roxo* | *Tabebuia avellanedae* Lorentz *ex* Griseb | Bignoniaceae | C | 2229 |
| n *jacarterão* meadow beauty | *Miconia* sp. | Melastomataceae | D | |
| n *laranjeira do mato* | *Zollernia illicifolia* Vog. | Caesalpinaceae | N | 6761 |

| Plant Names Common | Scientific | Family | Uses | Voucher Number (AB, UEC) |
|---|---|---|---|---|
| n *paina* silk cotton tree | *Pseudobombax grandiflorum* (Cav.) A. Robyns | Bombacaceae | CW | 37847 |
| n *pequeá* *guatambu* white quebracho | *Aspidosperma tomentosum* Mart. | Apocynaceae | D | 31791 |
| n *pequeá rosa* white quebracho | *Aspidosperma tomentosum* Mart. | Apocynaceae | DH | 32874 |
| n *sape* grass | *Imperata brasiliensis* Trin. | Gramineae | R | 16906 |
| n *tabucúba* | *Pera obovata* Baill. | Euphorbiaceae | DH | 40364 |
| n *tambatarú* prickly ash | *Zanthoxylum rhoifolium* Lam. | Rutaceae | PW | 14250 |
| n *taquara* bamboo | *Merostachys* sp. | Gramineae | A | |
| e *taquaruçú* yellow bamboo | *Bambusa* sp. | Gramineae | A | |

[1]most canoes are built with this tree.

one canoe. It took nine men about six hours to move the canoe from the forest to the harbor due to the island's steep topography (Fig. 6).

Medicinal plants are used at Búzios along with medicines prescribed by the clinic *(Posto de Saúde)* at Ilhabela. However, the relative importance of medicinal plants may also be drawn from the mention made to them during interviews (Fig. 7). The most frequently mentioned plants were wormseed *(canema)* (*Chenopodium ambrosioides* L.), lemon verbena *(cidreira)* (*Lippia citriodora* H.B.K.), fennel *(erva doce)* (*Foeniculum vulgare* Gaertn.), spearmint *(hortelã-preta)* (*Mentha spicata* L.), and wormwood *(losna)* (*Arthemisia absinthium* L.), plants used for the treatment of worms, cough, and influenza (Table 4). Worms are a common childhood ailment; intestinal problems often occur among adult islanders as well.

During interviews we noted that some less commonly reported plants (Fig. 7) were mentioned by older people. Older people were commonly cited by younger interviewees as being knowledgeable about medicinal plants. It is likely that much of the older generation's knowledge about medicinal plants is not being passed on to the younger generations, since the young tend to be more faithful visitors of the clinic than are the older people. This substitution or loss of knowledge concerning local medicinal plants is similar to Anderson's (1986b) observations for the Lahu in Northern Thailand. Despite the difficulty of obtaining modern medical care and some complaints about its effectiveness, Búzios islanders use both modern and traditional treatments. About half of the plants used in medicine on Búzios are introduced (Table 4). These plants illustrate the significant influence of the Portuguese on the southeast coast of Brazil.

FIG. 6.—Unfinished canoe made of *Alchornea iricurana,* Euphorbiaceae, transported by fishermen from the forest to Porto do Meio harbor.

Willems (1952) reported four plants used in islanders' "curative magic" and one, common rue *(arruda)* (*Ruta graveolens* L.), described as used against the "evil eye," is still used at Búzios to "dispel bad spirits" (Table 4).

In general, plants play a fundamental part in the life of islanders. However, some rare plants, such as trees of the genera *Ocotea* (cinnamon) *(canela), Tabebuia (ipê), Zollernia (laranjeira do mato),* and *Aspidosperma* (white quebracho) *(pequeá),* may likely be lost due to their rare occurrence and the fact that islanders are obligated to take the tree trunk for constructing docks, houses, or canoes. On the other hand, some medicinal plants are easy to collect and, as readily available means to treat common illnesses and an alternative to modern medical care, are more likely to be maintained in the islanders' culture.

## COMPARISON WITH MEDICINAL USES OF PLANTS IN OTHER BRAZILIAN REGIONS

Wormseed is used against worms in the Amazon (Van den Berg 1978) and in most Brazilian states (Cruz 1979). Lentz (1986) reported this plant as used against stomachaches among the Jicaque Indians (Honduras). According to Bye (1986), the antihelmenthic properties of wormseed have been long recognized in traditional American cultures; its oil contains the active principle.

Other plants listed in Table 4 are also used in most areas of Brazil for medicinal purposes. These include wormwood (Junqueira 1980), guava, and tropical ageratum *(mentrasto)* (*Ageratum conyzoides* L.) (Cruz 1979). Use of this last was also reported for Thailand by Anderson (1986a). *Pothomorphe umbellata* (L.) Miq.

FIG. 7.—Medicinal plants mentioned in interviews (n = 28) at Búzios Island; citations were based on popular names; ? = popular name: *cipó de palmera*.

TABLE 4.—Medicinal plants used at Búzios Island. Native (n) and exotic (e) species. Some teas made with medicinal plants may be mixed with *pinga*, a Brazilian beverage made of sugarcane. Two plants used to ward off bad luck or spirits are included. Refer to Begossi (1989) for more detail on these plants.

| | Common Names | Scientific Name Family Voucher Number | Uses (part) |
|---|---|---|---|
| e | *abacate* avocado | *Persea americana* Mill. Lauraceae | painful urination, with *erva tostão,* liver problems, with *parióba* (leaves: tea) and *jerbão* |
| e | *agrião* watercress | *Nasturtium officinale* R. Br. Cruciferae | influenza (leaves: syrup) |
| n | *aguiné* | *Petiveria tetrandra* Gomez Phytolaccaceae AB 8881, UEC | bad luck and spirits (leaves: bath) |
| e | *alho* garlic | *Allium sativum* L. Liliaceae | snake-bites (bulbs: pounded) |
| n | *ambuta* | *Abuta* sp. Menispermaceae | anemia, after childbirth, abortifacient (bark: tea) |
| n | *anica* | *Indigofera suffruticosa* Mill. Fabaceae AB 8499, UEC | any illness (leaves: bath, tea) |
| n | *araçá* guava | *Psidium cattleyanum* Sabine Myrtaceae AB 32875, UEC | diarrhea (fruit peel: tea) |
| e | *arruda* common rue | *Ruta graveolens* L. Rutaceae | abortifacient, to expell bad spirits or bad luck (leaves: tea, bath) |
| n | *baleeira* | *Cordia* sp.2 Boraginaceae | rheumatism (leaves: pounded) |
| e | *banana* bananas | *Musa acuminata* Colla Musaceae | boils, thorns (leaves) |
| e | *boldo* | *Coleus barbatus* Benth. Labiatae | liver, stomach, diarrhea (leaves: raw, pounded, tea) |
| n | *boldo* | *Vernonia condensata* Baker Compositae AB 41024, UEC | diarrhea (leaves: pounded with water) |
| n | *caju* cashew | *Anacardium occidentale* L. Anacardiaceae AB 30087, UEC | diarrhea (fruits) |
| e | *camomila* camomila | *Matricaria chamomilla* L. Compositae | diarrhea (tea) |
| e | *canema* wormseed goosefoot | *Chenopodium ambrosioides* L Chenopodiaceae AB 1337, UEC | diarrhea, worms (leaves: pounded, with sugar/milk, tea) plaster for injuries (leaves: pounded with salt) |
| n | *capoquinha* | *Hyptis suaveolens* Poit. Labiatae AB 21001, UEC | injuries (leaves: pounded with *pinga*) |
| n | *carqueja* | *Baccharis trimera* (DC.) Less. Compositae AB 43709, UEC | diarrhea, stomach, liver, high blood pressure (leaves: tea) |

| Common Names | | Scientific Name<br>Family<br>Voucher Number | Uses (part) |
|---|---|---|---|
| ? | *carrapicho de ferrao, carrapicho preto.* | ?<br>Compositae | painful urination (tea) |
| n | *chapéu de de couro* | *Echinodorus grandiflorus* Mich.<br>Alismataceae<br>AB 19875, UEC | rheumatism (leaves: tea) |
| n? | *cidrão* lemon grass | *Cymbopogon citratus* (DC.) Stapf<br>Gramineae | stomach, high blood pressure, sedative, cough, influenza (leaves: tea, syrup) sleeplessness (branches: under pillow) |
| e | *cidreira* lemon verbena | *Lippia citriodora* H.B.K.<br>Verbenaceae<br>AB 21008, UEC | cough, influenza, menstrual cramps, high blood pressure, sedative, stomach (leaves: juice with milk, tea, syrup) |
| n | *cipó de cobra* | *Mikania cordifolia* (L.f.) Willd.<br>Compositae<br>AB 48639, UEC | snake-bites (tourniquets) |
| ? | *cipó de palmera* | ? | snake-bites (tourniquets) |
| n | *cipó de são joão* | *Pyrostegia venusta* (Ker-Gawl.) Miers<br>Bignoniaceae<br>AB 808, UEC | snake-bites (tourniquets) |
| e | *coco* coconut | *Cocos nucifera* L.<br>Palmae | abortifacient (water: with *pinga*) |
| n | *cuvinha* | *Porophyllum ruderale* (Jacq.) Cass<br>Compositae<br>AB 40328, UEC | diarrhea (leaves: bath, tea) |
| e | *erva doce* fennel | *Foeniculum vulgare* Gaertn.<br>Umbelliferae | influenza, worms, diarrhea, child colics, asthma, headaches (leaves: tea, pounded for plaster and poultice) |
| n | *erva tostão* | *Boerhaavia diffusa* L.<br>Nyctaginaceae<br>AB 40298, UEC | hepatitis (roots: tea) |
| e | *eucalipto* eucalyptus | *Eucalyptus* spp.<br>Myrtaceae | injuries, rheumatism (leaves: pounded with *alcool* for plaster) |
| n | *goiaba branca* guava | *Psidium guajava* L.<br>Myrtaceae<br>AB 12227, UEC | diarrhea (buds: tea) |
| e | *guando* red gram | *Cajanus cajan* (L.) Mill.<br>Fabaceae<br>AB 24606, UEC | toothaches (leaves: tea) |

TABLE 4.—Medicinal plants used at Búzios Island. Native (n) and exotic (e) species. Some teas made with medicinal plants may be mixed with *pinga,* a Brazilian beverage made of sugarcane. Two plants used to ward off bad luck or spirits are included. Refer to Begossi (1989) for more detail on these plants. (continued)

| | Common Names | Scientific Name Family Voucher Number | Uses (part) |
|---|---|---|---|
| e | *hortelã* mint | *Mentha* sp. Labiatae | diarrhea, worms (leaves: tea) |
| e | *hortelã preta* spearmint | *Mentha spicata* L. Labiatae | diarrhea, worms, cough, bronchitis (leaves: tea, syrup) |
| n | *jerbão* | *Stachytarpheta polyura* Schauer Verbenaceae AB 46180, UEC | liver (leaves: tea with *parióba*) |
| e | *laranja* orange | *Citrus sinensis* (L.) Osbeck Rutaceae | influenza (leaves: tea) |
| e | *limão* lemon | *Citrus aurantifolia* Swing. Rutaceae | toothaches, influenza (leaves, fruit peel: tea, syrup) |
| e | *losna* wormwood | *Artemisia absinthium* L. Compositae | stomach, diarrhea, worms, abortifacient (leaves: tea) |
| e | *louro* | *Laurus nobilis* L. Lauraceae AB 31842, UEC | sour-stomach (leaves: tea) |
| n | *maracujá* passion-flower | *Passiflora edulis* Sims. Passifloraceae AB 12714, UEC | high blood pressure, heart, toothaches (leaves, buds: tea) |
| e | *mentrasto* tropical ageratum | *Ageratum conyzoides* L. Compositae AB 35030, UEC | poultice for sprains (leaves: pounded with salt or vinegar). Formerly the leaf juice was drunk after childbirth |
| e | *mentrus* cress | *Lepidium virginicum* L. Cruciferae AB 3955, UEC | injuries, pneumonia (leaves: tea) |
| n | *paliatéia* | *Acalypha poiretti* Spreng. Euphorbiaceae AB 49736, UEC | diarrhea (leaves: tea) |
| n | *palma de mandacarú* | *Opuntia* sp. Cactaceae | snake-bites, boils, (cladode: eaten, juice with corn starch for boils). |
| n | *parióba* | *Pothomorphe umbellata* (L.) Miq. Piperaceae AB 12819, UEC | liver, kidney (leaves: tea) |
| e | *picão* railway beggarticks | *Bidens pilosa* L. Compositae AB 38864, UEC | injuries, itching, hepatitis (mixed with *tambatarú* in tea) (leaves: baths, tea) |
| n | *pitanga* Brazilian cherry | *Eugenia uniflora* L. Myrtaceae AB 11745, UEC | painful urination (leaves: tea with *goiaba* and *erva tostão*) |

| Common Names | Scientific Name Family Voucher Number | Uses (part) |
|---|---|---|
| n *prumera* | *Mikania* sp. Compositae | snake-bites (leaves: juice) |
| e *puejo* pennyroyal | *Cunila spicata* L. Labiatae | influenza, cough, diarrhea, worms (with *hortelã preta*) (leaves: tea, syrup) |
| n *quebra-pedra* fly-roost leafflower | *Phyllanthus corcovadensis* Muell. Arg. Euphorbiaceae AB 40860, UEC | painful urination (leaves: tea) |
| e *sabugueiro* elderberry | *Sambucus australis* Cham. & Schlecht Caprifoliacae AB 1267, UEC | measles (tea) |
| n *santa luzia* | *Euphorbia pilulifera* L. Euphorbiaceae AB 40253, UEC | stomach (leaves: tea) |
| n *sapé* grass | *Imperata brasiliensis* Trin. Gramineae AB 16906, UEC | abortifacient (seeds with salt, aspirin, and coca-cola) |
| n *tambatarú* prickly ash | *Zanthoxylum rhoifolium* Lam. Rutaceae AB 23043, UEC | hepatitis (bark: tea) |

*(parióba)* and *Petiveria tetrandra* Gomez *(aguiné)* are used in Amazonia (Van den Berg 1978). *Baccharis trimera* (DC.) Less. *(carqueja), Hyptis suaveolens* Poit. *(capo-quinha),* and prickly ash *(tambatarú)* (*Zanthoxylum rhoifolium* Lam.) have medicinal uses in west-central Brazil, where savanna *(cerrado)* vegetation dominates (Siqueira 1988). Use of *Hyptis suaveolens* was also reported in northeast Brazil (Paraíba State) by Agra (1980). Of the major medicinal plants used on Búzios, wormseed, fennel, wormwood, lemon grass (*Cymbopogon citratus* (DC.) Stapf), common rue *(Baccharis trimera),* camomila (*Matricaria chamomilla* L.), and water-cress *(agrião)* (*Nasturtium officinale* R. Br.) are described by Santos et al. (1988) as being in general use for similar purposes elsewhere in Brazil.

Lemon grass tea (Table 4) is used in most Brazilian regions as a sedative, but treatments presumably depend on a placebo effect as no pharmacologically active compound has been found in this plant (Carlini 1985). Pharmacological activity has been found in passion fruit (*Passiflora edulis* Sims) (Valle and Leite 1978), and antiseptic properties are attributed to *Eucalyptus* (Thomson 1978). As stressed by Schultes (1978), the overwhelming number of modern medicines deriving from traditional pharmacopoeias should convince medical scientists about the value of ethnopharmacological investigation.

## THE DIVERSITY OF PLANTS USED

The diversity of plants used at Búzios, compared to other communities, is high. Johnson (1983) collected data on 80 plants used by the Machiguenga Indians (Upper Amazon, Peru) as food, fish poison, and medicine, among other uses. Data collected in the Amazon forest (Rondônia State) by Coimbra (1985) from 300 Suruí Indians indicate that 58 species from 25 families were used for a variety of purposes. Posey (1983) estimated that the fruits of 250 plants are used by the Kayapó Indians. At Búzios, we found 128 species belonging to 56 families used for food, housing, canoe construction, handicrafts, and medicine. These are plants found in forested (Atlantic Forest) and deforested areas of the island.

## CONCLUSIONS

The results of this study show that even in a community that has switched from a dependence on agriculture to an economic emphasis on fishing, for both cash and subsistence, people remain highly dependent on local plant resources for a variety of uses. However, knowledge of tradition herbal medicine is declining. A few plants have been dropped from cultivation and are now purchased, but subsistence production of most historic crops remains important. Use of collected plant resources for construction, fuel, handicrafts, and food remains essential to the economy of the community.

These observations are important for management purposes. The remaining Atlantic Forest vegetation is considered a top priority for conservation and is included in the Biosphere Reserve Program (MAB/UNESCO) (Lino 1992). Small and relatively isolated communities like Búzios are often located in conservation areas. Búzios Island is part of the State Park of Ilhabela *(Parque Estadual de Ilhabela),* which is an archipelago including São Sebastião Island and other small islands (SEMA 1991). The continuing, rather intensive use of land for gardens and forest for gathered resources by these communities should be recognized in any conservation or management proposal.

## NOTES

[1]Plants without voucher numbers are either common cultivated plants or were identified by comparing material without diagnostic parts (and thus could not be deposited in the Herbarium); for this material, only generic names are given. Many plant classifications were based on Joly and Leitão-Filho (1978). English plant names were based on Alzugaray and Alzugaray (1984), Junqueira (1980), Taylor (1985), and Thomson (1978).

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# RECENT DOCTORAL DISSERTATIONS OF INTEREST TO ETHNOBIOLOGISTS: FALL 1992–FALL 1993

TERENCE E. HAYS
*Department of Anthropology and Geography*
*Rhode Island College*
*Providence, RI 02908*
and
JOSEPH E. LAFERRIÈRE
*Arnold Arboretum of Harvard University*
*22 Divinity Ave.*
*Cambridge MA 02138*

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## BOOK REVIEW

**Pollen Flora of Maharashtra State, India.** T.S. Nayer, New Delhi, India: Today and Tomorrow's Printers and Publishers, 24B/5,D.B. Gupto Road, New Delhi 110005, India; Houston, TX: Scholarly Publications, 7310 El Cresta Drive, Houston, TX 77083, U.S.A. Pp. xi, 157, 67 plates.

The study of pollen in regions as distant and different floristically as that of the state of Maharashtra in India represents a most welcome addition to palynology. This book is the product of intensive and extensive scholarly research and will long remain a consultative work for botanists in general.

Following Takhtajan's system of classifications it treats pollen in 87 families. The first chapter provides an excellent detailed discussion of the principles of palynology. Chapter 2 concerns methodology and discussion of terminology, microphotography, nomenclature, illustrations and family arrangements. Chapter 3 outlines aspects involved in pollen keys. The fourth chapter offers systematic descriptions of pollen by families, genera, and species. There follow an extremely extensive selected bibliography, glossary of palynological terms, and a scientific index. The 67 plates, each with 6 or more microphotographs, are of the highest quality. The author must be congratulated for producing such a masterly piece of research.

Richard Evans Schultes
Harvard Botanical Museum
Cambridge, Massachusetts

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# ABSTRACTS

## *of presentations (contributed papers and poster sessions) at the Sixteenth Annual Conference of the Society of Ethnobiology*

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**E.N. ANDERSON,** Department of Anthropology, University of California, Riverside, CA 92521

**BACK TO GILMORE**

Ethnobiology has a long tradition of documenting traditional strategies for conservation and sustainable use of biotic resources. Early writers such as Melvin Gilmore, the founder of ethnobiology as an academic teaching discipline, concentrated on such strategies and the world view that produced them. Recently, an all-out attack has been launched against the "romantic," "noble-savage" view that traditional peoples are capable of such ideology and behavior. Biologists (e.g., Jared Diamond, *The Third Chimpanzee,* 1992) and geographers (e.g., Martin Lewis, *Green Delusions,* 1992) have been particularly evident in this line of argument. These attacks could be ignored if it were not for the fact that they have informed, if not inspired, right-wing anti-environmentalist figures of national media importance, such as Rush Limbaugh (*The Way Things Ought to Be,* 1992), and also political figures. It would appear that ethnobiologists need to set the record straight, or at least present relevant evidence. Some tentative and exploratory leads are suggested in this paper, bringing ethnobiological work (from Gilmore's on to the present) together with such sources as autobiographies of indigenous peoples, recorded texts such as *Native Ethnography* by Russell Bernard and Jesus Salinas, and similar primary source materials.

**Kurt ANSCHUETZ,** Museum of Anthropology, University of Michigan, Ann Arbor, MI 48109

**HARVESTING FROM THE PERIPHERY TO PRESERVE THE WHOLE: THE SIGNIFICANCE OF PLACE AND THE COLLECTION OF PLANTS AND ANIMALS FOR MAJOR HOPI CEREMONIES**

Anthropologists have demonstrated that humans use culture to construct meanings for the world that they occupy and experience. Ethnobotanists have made important steps in developing frameworks for evaluating the cultural sig-

nificance of plants used by Native Americans living within particular traditional communities. Of interest to the present study is the formal recognition by scholars that plants distinguished by Native Americans are conceptualized neither as discrete nor unconnected entities. Recent ethnobotanical studies, which have considered the systems of knowledge possessed by indigenous cultural communities concerning the uses and non-uses of flora, have shown that plants are considered to be integral components of larger geographic areas. It seems reasonable that similar principles of understanding apply to a native people's recognition and perception of animals.

Whereas previous scholars emphasize the economic roles of resources in evaluating of cultural significance, I suggest that the concept of place, which underlies the relationship among plants, animals, and geographic areas in native peoples creatively occupy and transform their landscapes. The underlying thesis is that fundamental religious beliefs not only guide how members of an indigenous community use their physical landscape to earn their livelihood, but also inform how they use and think about their natural environment to maintain their cultural well-being. The incorporation of such fundamental reasoning rules in models for evaluating cultural significance can provide insights into how seemingly ephemeral, esoteric uses of plants and animals may be essential for the preservation of an indigenous human community as a viable and distinct cultural entity.

I illustrate this argument through an analysis of ethnographic observations about the collection of small numbers of plant and animal resources from the periphery of the *Tusqua,* the traditional homeland of the Hopi Pueblo Indians of northeastern Arizona, by individuals representing the clans that compose Hopi society. I show how these products, which are used to produce prayer offerings and paraphernalia needed for some of the most sacred rites in the Hopi annual ceremonial calendar, are conceptualized by the Hopi as essential for fulfilling their sacred obligation as the stewards of the *Tusqua* to preserve a state of harmony in the whole of the cosmos. Moreover, I consider how the physical act of undertaking journeys to distant places at the edge of the Tusqua to obtain plant and animal products becomes one means through which the Hopi reenact their past, reaffirming the legitimacy of the cultural principles that inform how the Hopi live in the present and prepare for the future.

**Alejandro de AVILA,** Department of Anthropology, University of California, Berkeley, CA 94720

**ORANGES GO WITH GUAVAS: MIXTEC BIOLOGICAL NOMENCLATURE AFTER EUROPEAN CONTACT**

Mixtec is a group of closely related languages spoken mostly in western Oaxaca, in southern Mexico. This paper describes the effect of the introduction after 1519 of plants and animals from the Old World in Mixtec biological nomenclature. I compare Mixtec terms registered in sixteenth-century documents (a Spanish-Mixtec vocabulary, a Mixtec grammar, and a few geographical descriptions) with contemporary terms used in a sample of communities throughout the Mixtec region. Three naming processes appear to take place after the Spanish

conquest: (1) the extension of indigenous categories to encompass introduced species, usually adding an epithet to either the introduced or the original referent (e.g., *tikuan,* "guava," becomes "orange," and guava is rendered as *tikua ndiki,* "seedy orange"); (2) new Mixtec terms are coined for introduced species; and (3) very rarely, Spanish terms are borrowed. I attempt to understand how different semantic contexts appear to correlate with each of the three processes. I find a single, minor case of borrowing from Nahuatl, a language widely used in southern Mexico before and after European contact.

**Daniella BAR-YOSEF,** Peabody Museum, Harvard University, 11 Divinity Ave., Cambridge, MA 02138

**THE ECONOMIC ROLE OF SHELLS IN THE NEOLITHIC THROUGH BRONZE AGE IN THE SOUTHERN LEVANT**

Several case studies of assemblages of marine and freshwater mollusk shells are discussed. Southern Sinai Neolithic (PPNB) marine shells were collected from the Mediterranean and the Red Sea, shaped and used as beads for various body decorations, including clothes (i.e., Nahal Hemar Cave), and plastered skulls (Jericho). It is suggested that PPNB hunter-gatherers traded shell beads for grains with farmers in the sown land. Preliminary study of unique Early Bronze Age mollusks from Tel Qashish suggests that freshwater clams *(Potomida littoralis)* were consumed as a result of a stressful socio-economic situation.

**Barrett BRENTON,** Department of Anthropology, University of Massachusetts, Amherst, MA 01003–0020

**FOOD STORAGE: ETHNOBIOLOGICAL AND ECOLOGICAL PERSPECTIVES**

The Hopi have maintained a number of traditions in the desert of the American Southwest. Most research on the Hopi has focused on religious ceremonies, social structure, and dry land farming. Little documentation exists for traditional methods of food processing, especially storage. This paper discusses the ethnobiology and ecology of contemporary Hopi storage practices and transitions that have taken place over time. This research was part of a project working with the Hopi on documenting change in traditional foodways and diet.

Part of this documentation is concerned with an increase in storage loss due to changes in storage practices. In the past, food storage was critical to food security by buffering the effects of fluctuating availability and by avoiding famine. Today food supplies are limited mainly by one's cash resources. The use of traditional Hopi foods and the need for storage are now almost entirely an expression of Hopi identity, not survival. The importance of this identity is seen most distinctly in a constant demand for corn and corn-based foods for ceremonies. This demand is related to a continued, although diminished, maintenance of Hopi storage practices. Storage also serves as an intermediate indicator between food production and consumption. It can be used as a secondary indicator, reflecting patterns of change in farming and the use of traditional foods.

A summary of ethnographic interviews is presented to reflect a change in the ethnobiology of food storage architecture and maintenance. The ecology of stor-

age areas is discussed with respect to insect and microbial pests and corresponding storage loss. This is related to a general decrease in the production and use of traditional Hopi foods with a corresponding increase in diet-related disease. Finally, the importance of documenting the ethnobiology and ecology of storage areas for developing appropriate storage technologies is highlighted.

This research was funded in part by a Wenner-Gren Foundation Pre-doctoral Grant and a University of Massachusetts Graduate Fellowship. This project was conducted from 1990–1991 under a research permit issued by the Hopi Tribe, Kyotsmovi, Arizona.

**Carmen BURCH,** Connecticut College, Box 5427, New London, CT 06320

**THE GENDER OF THE GARDEN IN BANGLADESH**

Homestead gardens in Bangladesh traditionally have been the domain of women, but now the "gender" of these gardens is being "reversed" in the wake of development efforts to counter the growing poverty of rural households. Based on field survey data from three regions in Bangladesh, this paper assesses the changing definition and role of homestead gardens as elements in household-based, rural farming systems. Until recently, homestead gardening has been notable for its invisibility—a condition that can be understood in two ways. First, as polycropped gardens planted within the private space of the family compound, homestead gardens lack the orderly profile of monocropped fields, are physically quite hidden, and so easily go unnoticed. Second, farming activities are equated with the production of field crops, and field crops are the domain of men. Due to the association of homestead gardens with women, who are by definition not "farmers," these gardens are not perceived as significant sources of food and nonfood crops. Recent agricultural surveys fail to support the view that homestead gardens contribute only marginally to the welfare of rural households. Findings such as these have triggered a spate of NGO and government-sponsored development projects that seek to intensify and expand homestead garden production. Although the vital role of these gardens is beginning to be recognized, the vital role of women, as the crafters of these gardens, is not. Homestead garden projects designed to be "gender-neutral" or to target "farmers" effectively target the men, not the women of Bangladesh. The result is a displacement of women in a domain of traditional expertise.

**Robert BYE** and **Edelmira LINARES,** Jardín Botánico, Instituto de Biología, Universidad Nacional Autónoma de México, Apdo. Postal 70–614, 04510 México, D.F., México

**AZTEC BUREAUCRATIC CURES: SIXTEENTH CENTURY HERBAL REMEDIES FOR GOVERNMENT OFFICIALS IN MEXICO**

The De La Cruz-Badianus Manuscript, written in 1552, is the first New World herbal and is one of the few early documents whose contents were not significantly altered by European concepts of that period. One chapter is of particular interest because it relates to an important Aztec health condition that was not recognized by the Europeans at the time—that is fatigue of public officials.

Several plants, 22 of which are named, were consumed in addition to animals and stones. Of these herbal remedies, 12 have been identified to species, seven to genera, and two to family. Ten taxa are native to the Valley of Mexico where the rulers resided while 11 are found outside and were presumably supplied by the provinces to the leaders of the Triple Alliance Empire. The specificity of certain plants is demonstrated by the fact that seven are mentioned only for this treatment and no other in the Herbal. The remaining plants are included in other remedies, the most common of which are those associated with culturally-based disorders such as travelers' ailments and lightening wound (?fright). Some plants may have been used principally for their ritual properties (e.g., ornamentals, aromatics, etc.) while others may have had pharmacological effects such as those containing essential oils. Of the 19 identifiable plants, 15 are employed currently in central Mexico and include the following: for medicinal purposes: *Alnus, Arctostaphylos, Chrysactinia, Cordia, Haematoxylon, Magnolia, Pinus, Quercus, Senna;* for ritual functions: *Abies, Plumeria;* and for food: *Theobroma, Vanilla, Peperomia, Spondias.*

**Felix COE** and **Gregory J. ANDERSON,** Department of Ecology and Evolutionary Biology, University of Connecticut, Box U-43, 75 N. Eagleville Rd., Storrs, CT 06269–3043

**ETHNOBOTANY OF THE MISKITU, SUMU, RAMA, AND GARIFUNA OF EASTERN NICARAGUA**

We present a preliminary report on the ethnobotany of the four indigenous groups in eastern Nicaragua: the Miskitu, Sumu, Rama, and Garifuna. The history and current status of each group is given, followed by a description of the study areas. This area is changing rapidly as a consequence of several years of civil strife, natural disasters, and, more significantly, the construction of new access roads. Years of informal study were supplemented by four months of intensive study. The latter focused on interviews and field studies with six shamans and 20, others such as midwives, familiar with the application of plant-derived medicines. We report the diversity of use of plant material in all facets of the lives of the native people, especially the Rama and Garifuna, but focus on medicinal applications. To date, some 300 species of plants have been documented as having application to treating more than 30 human ailments. These studies are important because new treatments may be found for human diseases. However, as important, or perhaps more so, given the very rapid rate of westernization of the local folklore, this study will provide a written record of folk medicine and ethnobotany for the present and future generations of the indigenous groups.

**Demorest DAVENPORT, John JOHNSON,** and **Jan TIMBROOK,** University of California, Santa Barbara; Santa Barbara Museum of Natural History

**THE CHUMASH AND THE SWORDFISH**

Beginning at least 2000 years ago, a productive fishery for swordfish (*Xiphias gladius)* existed among the Chumash Indians of south central California. Prehistoric fishing technology is reconstructed and compared with that employed to take swordfish today. Archaeological, ethnographic, linguistic, and historical evi-

dence is presented to demonstrate that the swordfish also had mythical and ceremonial importance for the Chumash. Swordfish rituals and regalia, as well as the personification of the swordfish in Chumash oral tradition, suggest that a shamanistic cult surrounded the swordfish in Chumash culture. We propose that the swordfish cult was related to the Chumash belief that swordfish attacked whales and drove them ashore, a belief that is shown to be founded in fact.

**Deborah DUCHON,** Center for Applied Research in Anthropology, Georgia State University, 4 Carlisle Way NE, Atlanta, GA 30308

***Solanum nigrum:* FOOD, MEDICINE, OR POISON?**

Paradoxically, black nightshade *(Solanum nigrum),* considered a poisonous weed in the temperate zone, is valued in the tropics as food and medicine. Further, although toxicological research on the *S. nigrum* complex has been relatively limited, a "sister" species, *S. tuberosum,* has been the subject of much study, providing data on the steroidal alkaloids found in *Solanum* generally. The Hmong, a Southeast Asian refugee group which immigrated to the United States after the Vietnam War, gathers wild black nightshade and cultivates an allied species, possibly *S. americanum,* for use as a leafy green vegetable and tonic for the elderly. Using toxicological literature, participant observation, and survey research among the Hmong, as well as self-experimentation, this paper examines the apparent contradiction between temperate/tropical perception and usage, and possible implications of prolonged *Solanum* ingestion among susceptible individuals.

**Leslie JOHNSON GOTTESFELD,** Department of Anthropology, University of Alberta, Edmonton, Alberta T6G 2H4

**CONSERVATION AND TRADITIONAL GITKSAN AND WET'SUWET'EN BELIEFS**

In this paper I review aspects of the culture, resource exploitation, and beliefs of Gitksan and Wet'suwet'en peoples of northwestern British Columbia to examine the relationship of their cultural practices and beliefs to resource conservation. I hypothesize that if a subsistence adaptation has been stable, then conservation must be occurring, given two factors: (1) possession of technology adequate to over-harvest a given resource, and (2) reliance on animal and plant species whose life cycle occurs within the range occupied by the people so that fluctuations in the abundance of the species exploited can be correlated with the behaviour of members of the group. I assume geographic stability without major incursion by outside groups as a factor in a stable subsistence adaptation. The concepts of humans as part of the natural world, not distinct from it, and the requirement for respect for all natural entities mediate human interactions with other species in the Gitksan and Wet'suwet'en cultures. The constellation of Gitksan and Wet'suwet'en practices and beliefs contain elements which acted to promote conservation, and other elements which, from our external perspective, do not appear to be intimately related to the productivity of resources or to their oconservation. Territory and proscription of waste act to limit resource exploitation. Ritual disposal of carcasses, and taboos restricting the contact of menstruating and pubes-

cent women with fish, game, and berry patches, are more difficult to reconcile with a biological model of conservation.

**José GONZÁLEZ RODRIGO** and **Regina LEAL GÜEMEZ,** Universidad Autónoma Metropolitana-Iztapalapa, Av. Michoacán y Purísima Col. Vicentina, Iztapalapa, México 09340, D. F., Apdo. Postal 55–536, México

**COMMERCIAL DEMAND AND MANAGEMENT OF NATURAL RESOURCES IN A NAHUATL PEASANT COMMUNITY**

A very important element in the socioeconomic dynamics of peasant indigenous communities are the market relationships with the socioeconomic environment with which the communities are involved. In the case of the Santa Catarina del Monte community in the Valley of Mexico, the commercial relationship is with the markets of Texcoco and Mexico City. This relationship, viewed in the temporal dimension and taking into account the evolution of market demand, provokes adjustments in the management of natural resources in the community, adjustments that we can see in changes of economic strategies for adaptation in the changing demand of market products. In this paper we present a diachronic revision of the form and changes in the utilization of natural resources, as a response to commercial demand in the markets of Sonora, Merced, Jamaica, and the Central de Abastos in Mexico City. These market places are the principal centers of commerce for the peasant products of the region.

**Yannis HAMILAKIS,** Department of Archaeology and Prehistory, University of Sheffield, Sheffield, S10 2TN, England

**TOWARDS AN ECOLOGICAL ARCHAEOLOGY OF CONSUMPTION**

The dominant approaches in ecological archaeology pay very little attention to consumption and, most importantly, perceive it mainly as a biological phenomenon. This paper, drawing on the anthropology of consumption and partly on structuralist thinking, as well as on anthropological and historical literature, tries to demonstrate the urgent need for an alternative approach. Consumption is perceived neither as an end, nor as an objective of production, but as an episode in the circular process, production-distribution-consumption. It is suggested that consumption should be examined as a process in its own right, but at the same time, the interconnections of production to consumption and distribution should be considered. It is emphasized that, at the time of its consumption, a product embodies the production and distribution meaning in it. Moreover, consumption is perceived as a code of communication, but it is stressed that it is far more complex than any language.

Special attention is given to food consumption and, with the citation of some anthropological and historical examples, the multidimensional role of food and drink consumption is demonstrated: food and drink consumption is shown to operate, among other things, as a marker of social inequalities, a signifier of tribal and national identity, a means of labor mobilization and exploitation, and a mechanism for the legitimization of power. Finally, an archaeological problem, the issue of Mediterranean polyculture in Bronze Age Crete, is very briefly re-examined in the light of the above thoughts.

**Carmen HENDERSHOTT,** New School for Social Research, New School Library, 65 5th Ave., New York, NY 10003

**GARDENS AND GARDENING IN THE FINDHORN COMMUNITY**

This paper describes the gardening experiment that inspired the birth and development of Findhorn Foundation, an international alternative community in the Scottish Highlands. It concentrates on the garden's role as locus of work activity, educational medium, and symbol in the post-1975 community. It argues that the garden, as both material reality and spiritual symbol, is a major resource for the construction of cultural meaning. Data is based on fieldwork and on literature by and about the community.

**Anne HENSHAW,** Department of Anthropology, Harvard University, Cambridge, MA 02138

**THE *INUPIAT* WHALING COMPLEX: A CASE STUDY IN CULTURAL SYNCRETISM**

Today whale hunting forms the ethnic core with which the *Inupiat* speakers of northwest Alaska identify. The stability of the whaling cult has persisted through a turbulent history of western contact and provides a unique opportunity to examine cultural continuity and change through time. Although formal changes have occurred as a result of interaction with western cultures, the social importance of whale hunting has maintained its significance in the lives of contemporary *Inupiat* and retains distinct continuities with the past.

The *Inupiat* whaling complex essentially underwent a cultural transformation as a result of contact. Through time this transformation manifested itself as a hybrid combining *Inupiat* cultural elements from the past with western technological developments introduced over the last 150 years of contact. Topics which highlight this transformation are explored. They include : (1) a discussion of the "traditional hunt"—*Inupiat* whaling as it existed during the early phases of contact; (2) the history of Euro-American whaling in northwest Alaska and its impact on the *Inupiat* whaling complex; and (3) an analysis of pictographic images collected from Point Barrow, Alaska, during the late nineteenth century which document the *Inupiat* perspective on transformations resulting from this intensive period of interaction.

**Lisa KLEIN,** University of Alaska, P.O. Box 80050, Fairbanks, AK 99708

**INCREASING THE USEFULNESS OF DATA ON UTERO-ACTIVE PLANT SPECIES: AN EMPHASIS ON TESTING AND METHODOLOGY**

The number of utero-active plant species which have gone from the stage of field recognition to medical application is surprisingly small. Using an ethnobotanical project examining the use of abortificient plants by the Quichua of the lower Amazon Basin as an example, a critique of methodology is presented to suggest ways to improve the viability of these data for continuing research in the clinical setting. The use of participant-observation methodology as well as directed interviews is suggested as a method to "test" preliminary plant lists. Im-

proving the accuracy of ethnobotanical data by testing results and including context of use, rates of use, and so on will increase interest in this area of ethnobotanical data by other disciplines.

**Dosia LAEYENDECKER,** Department of Anthropology, Smithsonian Institution, Washington, D.C. 20560

**ANALYSIS OF WOOD AND CHARCOAL SAMPLES FROM A EUROPEAN SITE AND NEARBY *INUIT* SITES IN FROBISHER BAY, CANADA**

Martin Frobisher's voyages to the Canadian Arctic during the summers of 1576–78 left behind relics that have been excavated in the remains of his camp on Kodlunarn island as well as in contemporary and later *Inuit* dwellings found in the area. Wood and charcoal samples were collected from these structures and identified to genus and where possible to species. Botanically the area is located within the southern region of the Arctic tundra. Local wood sources are restricted to small dwarf shrubs such as willow, birch, and heath plants. In the samples from the Frobisher structures European woods, among them oak and beech, occurred and some of these woods were possibly reused by the *Inuit*. Most of the samples from the Inuit sites derived from driftwood, including spruce, larch, and pine. This paper discusses the fieldwork and interpretation of driftwood in archaeological wood and charcoal samples.

**David LANDON,** Department of Social Sciences, Michigan Technological University, Houghton, MI 49931

**ZOOARCHAEOLOGICAL EVIDENCE FOR FOOD SUPPLY AND DISTRIBUTION SYSTEMS IN COLONIAL MASSACHUSETTS**

This paper is a comparative analysis of over 11,000 bones from two urban and two rural historical sites in eastern Massachusetts. Explicit hypotheses are evaluated about how the urban environment and particular characteristics of food supply and exchange systems affect specific aspects of faunal assemblage patterning. Taxonomic representation, body part representation, butchery patterns, and age and seasonal slaughtering patterns are all interpreted. The results of the analysis suggest that specialized husbandry to supply urban markets developed quite late, and that many aspects of urban food distribution systems during the Colonial period followed traditional rural patterns.

**Elizabeth J. LAWLOR,** University of California, 422 Campus View Dr., Riverside CA 92507–4030

**ACCOUNTING FOR BIAS IN ASSEMBLAGES RECOVERED BY FLOTATION: RESULTS OF EXPERIMENTS WITH MOJAVE DESERT RODENTS AND ANTS**

Experiments were conducted to sort cultural from noncultural effects on carbonized seeds. Ricegrass seeds were made available to rodents and ants. Variables included: distance from replicated seed-processing area, time since processing, location under shrubs or in the open, and raw or carbonized seeds. Diurnal and nocturnal rodents and harvester ants took carbonized seeds but significantly

preferred raw seeds. Short-term foraging intensity varied greatly within small areas but did not parallel intensity of cultural activities. Rodents left distinctive seed breakage patterns. These results offer clues for identifying and accounting for granivore-caused bias in macrofloral assemblages.

**Danna J. LEAMAN** and **J. Thor ARNASON,** Department of Biology, University of Ottawa, 30 Marie Curie, Ottawa, Canada K1N 6N5

**THE IMPORTANCE OF CULTIVATED PLANTS IN KENYAH DAYAK (BORNEO) TRADITIONAL MEDICINE**

This paper describes the use of cultivated medicinal plants by the Kenyah Dayak people of the Apo Kayan plateau in East Kalimantan, Indonesian Borneo. Recently developed quantitative techniques are used to evaluate the relative importance to the Kenyah of cultivated medicinal plant species, families, and types of use. The data analyzed are drawn from a more comprehensive study of Kenyah traditional medicines. The analysis shows that the ginger family (Zingiberaceae) is the most important source of cultivated medicines, although individual species in other families are more widely known and have a larger number of uses. The analysis also demonstrates the exceptional knowledge of female healers. The influence of foreign cultures and pharmacopoeias on the cultivated medicinal flora of Borneo peoples in general, and of the Apo Kayan Kenyah in particular, is discussed.

**Emily McCLUNG DE TAPIA,** Universidad Nacional Autónoma de México, México, D.F. México

**PREHISTORIC LANDSCAPE ALTERATIONS IN THE TEOTIHUACAN VALLEY, MEXICO**

Evidence from current paleoethnobotanical research at archaeological sites, as well as soil profiles located in the Teotihuacan Valley, Mexico, suggests that the heavily populated pre-Hispanic urban center dominating the region from 150 BC–AD 750 provoked intense alterations in the surrounding landscape. However, the reconstruction of prehistoric vegetation over time, based on stratigraphic studies of pollen, phytoliths, and macrobotanical remains, indicates that climatic variation together with the impact of human exploitative activities over a millennium, are also influenced by dynamic regional geomorphological processes such as erosion, sedimentation, and, possibly, continued volcanic activity. Preliminary results from the first season of field investigations and laboratory analyses are presented, with emphasis on methodological aspects of the research.

**Joy McCORRISTON,** Department of Anthropology, National Museum of Natural History, Smithsonian Institution MR. 112, Washington, DC 20560

**ARCHAEOBOTANICAL RESULTS FROM THE KHABUR DRAINAGE PROJECT, SYRIA**

The Khabur Basin Project is an interdisciplinary research effort devoted to reconstructing economic and environmental contexts of cultural development during the prehistoric and early historic periods in northern Mesopotamia. This

region today shows the effects of substantial human degradation and deforestation, yet neither the time depth of degradation nor the historic intervals of resource depletion and vegetation recovery are understood. By sampling many archaeological middens containing the debris from countless cooking fires, I use archaeological evidence of fuels to trace deforestation in the region. My expectation, a defensible premise given the geographical and cultural setting of Khabur sites, is that the woods recovered from the sites by and large reflect the site occupants' choices of fuel from the immediate environs.

This paper discusses some of the methodological problems in analyzing extremely small specimens, many of which derive from young branch growth, and it explores the implications of those identifications that could be made. In addition to riverine species, a number of unexpected forest trees appeared at prehistoric (6500–2500 B.C.) sites. Some, such as wild pistachio and wild almond, grow nearby in mountain refugia today. Of even greater interest are trees with no known local distribution, indicating an astonishing and hitherto unrecognized extent of the forest-steppe now greatly reduced through human agents.

**Katherine MOORE,** Department of Behavioral Sciences, Bentley College, 175 Forest St., Waltham, MA 02154–4705

**ANIMAL MANAGEMENT AND HEALTH IN THE TRANSITION TO DOMESTICATION**

Archaeological evidence from Peru documents the process of domestication of native wild camelids into the modern alpaca and llama. A long period of intense hunting led to skilled management and breeding of herds. One focus of human management of herds and pasture resources is the wear on the cheek teeth of grazing animals. Tooth wear rates vary according to the silica content of forage and the abrasiveness and quantity of soil taken in while feeding. Traditional herders monitor the wear on animal's teeth as a measure of potential longevity and health, and attempt to reduce the rate of wear by moving herds to less overgrazed pasture. Observations of teeth from archaeological specimens from Panaulauca (a large cave site in Junin, Peru) provide a measure of animal tooth wear across the transition to herding. Wild, hunted animals had the fastest rates of tooth wear, while early domesticated animals had slower rates of wear, suggesting the impact of human management. Modern animals in a well-managed herd had slower rates than any of the prehistoric herds, suggesting that early herders had less effective control of animal health. This information can be coordinated with other evidence for the fragility of some early food production systems.

**Gary NABHAN,** Native Seeds/Search, Rt. 1 Box 100, Ajo, AZ 85321and **S. ST. ANTOINE,** Yale School of Forestry and Environmental Studies, 55 Clark St. #2, New Haven, CT 06511

**KNOWLEDGE OF THE DESERT AMONG O'ODHAM, YAQUI, ANGLO, AND HISPANIC CHILDREN**

Few ethnobiological studies have focused on the knowledge and values which children have compared to that of their community elders. We interviewed 52

O'odham, Yaqui, Anglo, and Hispanic children between eight and fourteen years of age who live west of Tucson, Arizona, in the United States/Mexico borderlands of the Sonoran Desert. Their answers to a standard survey can be compared with those in classic ethnographies to suggest changes in the retention of traditional knowledge and values. Direct comparisons of ethnotaxa known by the Indian children with those known by their grandparents indicates that linguistic erosion has been dramatic over the last quarter century; with this loss of language is the loss of a tremendous reservoir of ethnobiological knowledge. Recommendations are provided to encourage the integration of cultural and environmental education in desert communities.

**Virginia NAZAREA-SANDOVAL,** Board of Environmental Studies, University of California, Santa Cruz, CA

**ROOTS OF DIVERSITY: WOMEN AS GENETIC AND CULTURAL CONDUITS**

It is increasingly recognized that narrowing the cultural and genetic diversity of any population predisposes that population to instabilities and makes it more vulnerable to ecological and social stress. Yet, given the homogenizing effect of agricultural development, both the genetic information coded in wild strains and farmers' landraces and technologies associated with traditional crop varieties are threatened with erosion and eventual loss. In the light of the complementarity between genetic and cultural diversity, the ramifying interlinkages between human decision making and intervention, on one hand, and biodiversity on the other, need to be explored.

This paper reports on a memory-banking research project carried out in Bukidnon, Philippines from 1990 to 1992. The term "memory-banking" refers to efforts to document indigenous knowledge and practices parallel to gene banking of agricultural crop varieties. Focusing on cultural management of sweet potatoes in subsistence-oriented and moderately commercialized areas, the study documented diversity of landraces as well as local beliefs and technologies associated with the crop. Life history elicitation, drawings, and ethnoscientific method were used to investigate local evaluation criteria, preferences, and relative salience of different features.

This paper examines why women are strategically situated to play a critical role in the maintenance of both genetic as well as cultural richness, complexity, and stability in agriculture over time. Life histories of women farmers, their drawings of sweet potato varieties from memory, and their evaluation criteria as gleaned from triads tests reveal a detailed and specialized knowledge of sweet potatoes and their cultivation. The results suggest that women as users of germplasm, decision makers in the maintenance and exchange of traditional varieties, repositories of indigenous knowledge, and socializing agents in all add up to women as actual and potential forces in the conservation of diversity of important crops.

**Enrique SALMON,** Department of Anthropology, Arizona State University, Tempe AZ 85287

**THE MARGINALIZATION OF INDIGENOUS ETHNOBIOLOGICAL KNOWLEDGE AS A RESULT OF FOREIGN CONTACT**

This paper offers a Native American's view towards the marginalization of the bearers of traditional plant knowledge and the knowledge itself. Marginalization refers to the academic shelving of indigenous knowledge to be replaced by its scientific categorization and interpretation. It is not my intent to discourage ethnobiological research by nonnatives. The intent is to acknowledge and encourage more contributions by indigenous authors to the ethnobiological community.

To most cultures knowledge is equated with power. To Native Americans the same is true. Historically, traditional knowledge and cultural history were verbally rendered and stored. The bearers of such knowledge were and are generally those that hold political and religious influence within the culture. Contact sometimes alters this situation. After contact, cultural knowledge often follows a course of submission, disappearance, rebirth, then marginalization. A latent effect of modern expeditions searching for natural product medicines is the marginalization of indigenous people's knowledge. Non-natives become the collectors and storers of indigenous knowledge. This collected knowledge is interpreted and categorized in academic studies so as to be used and understood by their own cultures. As a result they are in positions of power over indigenous peoples' knowledge when they use it to gain status and influence within the scientific community. The native knowledge in its original form is marginalized.

Today ethnobotanies by both nonindigents and native peoples provide, in many cases, the knowledge base of natural product medicines which were once stored in the minds of tribal specialists. Unfortunately, it is often the case that the source of the knowledge is recognized by non-native authors but is not accepted along with the knowledge. In many cases the knowledge itself is incomplete because its cultural interpretations and contextualizations have been omitted. The bearers of the information become "de-authorized." They are sent to the periphery to remain the "indigenous informers." There is now a need for native peoples to shake off their bonds of "indigenoustude." To demonstrate that native cultures are dynamically involved in the modern world we must be permitted and encouraged to present our knowledge as it is interpreted from its source. This is not to imply that ethnobiological research by non-natives should be curtailed. On the contrary, a synergism of both types of research can only present the clearest picture of ethnobiological knowledge.

**Enrique SALMON,** Department of Anthropology, Arizona State University, Tempe AZ 85287

## ASPECTS OF TARAHUMARA ETHNOBIOLOGY: PHYSIOLOGICALLY ACTIVE PLANTS WITH POTENTIAL TOXIC ACTIVITIES

Tarahumara herbalism utilizes approximately 300 plant species. Many of these are known to contain toxic compounds harmful to humans. This study will discuss some of those plants considered poisonous. The pharmacological characteristics of the plants will be revealed including constituents considered harmful, as well as beneficial to humans. Although all plants in this study are considered poisonous, that term is relative. One man's poison may be a Tarahumara's panacea.

The Tarahumara pharmacopoeia is respectable. Their relationship to natural medicines differs from that of Westerners. They recognize psychotomimetics,

plants considered sacred or powerful that must be treated with respect or fear. The result is that the biodiversity of the Tarahumara environment enriches and determines, to an extent, their social, personal, and cultural behaviour. This is especially evident when plants are interrelated with the Tarahumara concepts of disease and healing.

The presentation identifies and summarizes toxic plants used for medicines by the Tarahumara. Plants are identified by botanical nomenclature, common name in English and/or Spanish, and Tarahumaran name. Medicinally active biochemicals of each plant are described followed by the pharmacological affects the chemicals place on humans. Medicinal uses of the plants by the Tarahumara are then described. Because of their toxic contents, many of the plants of this study should be feared and respected. But this is a Western concept. Degree of toxicity is relative. The Tarahumara regard some plants with respect because of their commonly understood cultural model of plants that contain powerful spirits that, although potentially deadly, can heal the patient.

**Margaret SCARRY,** Program for Cultural Resource Assessment, University of Kentucky, 101 American Bldg., Lexington, KY 40506–0100 and **Elizabeth REITZ,** Museum of Natural History, University of Georgia, Athens, GA 30602–1882

**IN THE MELTING POT: HISPANIC AND NATIVE AMERICAN FOODWAYS IN *LA FLORIDA***

In 1565, Spanish colonists landed on the coast of Florida and camped in the Timucuan village of Chief Seloy. Shortly thereafter, they founded the colonial settlements of St. Augustine and Santa Elena and established missions along the Atlantic coast to South Carolina and, later, across the panhandle of Florida. Through labor drafts and proselytizing, the colonists pressured the Native Americans to adopt Hispanic lifestyles. Prolonged contact and interaction with Native Americans also resulted in changes, often unintentional or unwelcome, in Spanish lifestyles. For 15 years, we have investigated foodways in *La Florida* through the analysis of plant and animal remains from Native American and Spanish towns, forts, and mission settlements. By combining our data with archaeological and documentary evidence, we have gained insights about the impact of contact on Native American and Hispanic foodways.

**Judith SCHMIDT,** New York Botanical Garden, RR2, Box 5375, Union, ME 04862

**WHAT MIGHT A VISUAL ETHNOBOTANIST LEARN IN THREE WEEKS IN CHINA?**

Following the Second International Congress of Ethnobiology in Kunming, China, in 1990, I arranged to stay the additional three weeks allowed on a visitors visa. As an ethnobotanist and photographer it is rewarding to gather scientific data wherever one has an opportunity. This information proves valuable in communicating educationally with a general audience, as I do. In villages of two southern provinces a logical research focus proved to be the utilization of bamboo and the production of upland rice. Both are pervasive elements of village life in the south. The village dwellers constitute 80% of the more than one billion people

of China. Even a brief immersion in Chinese village life is, therefore, a temporary immersion in the very heart of China. Compiling a photographic record, I traveled by bicycle to ethnically varied villages in Yunnan Province, near the small towns of Junghong and Dali; also, in the Guangxi Zhuangzu Autonomous Region near the town of Yangshuo. The ethnic groups represented in the villages include Dai, Bai, and Hani. These southern regions show indications of the relaxation of market control as well as the traditional adaptations to a labor-intensive societal structure. The value of briefly researched ethnobotanical material for use as an educational tool will be demonstrated.

**Orrin C. SHANE, III** and **Gail E. WAGNER,** Department of Anthropology, University of South Carolina, Columbia 29208

**SEASONALITY AND DIET AT A FORT ANCIENT SITE**

Seasonal indicators within faunal remains separate summer from winter trash pits at the Incinerator site (33MY57), an A.D. 1250 Fort Ancient village in southwestern Ohio. The variety and cuts of meat indicate full-scale occupation of the village during the summer and partial occupation and provisioning during the winter. Faunal and botanical remains together provide a picture of seasonal diet at this early Fort Ancient village. Based on our findings, we propose a model for the seasonality of diet at Fort Ancient sites.

**G.K. SHARMA,** Biology Department, University of Tennessee, Martin, TN 38238–5014

**MEDICAL ETHNOBOTANY IN THE INDO-TIBETAN HIMALAYAS**

The Himalayas have always remained a treasure-trove of medicinal flora for traditional and modern medicine. The indigenous systems of medicine in the Indian subcontinent and the Amchi systems in Tibet rely upon the medicinal flora of this mountain complex. While some ethnomedicinal studies provide valuable information regarding the flora of some parts of the Himalayas, there is relatively little knowledge about the medicinal use of plants in the area under investigation. Higher elevations in the Himalayas have been quite elusive to botanical explorations. It is, therefore, logical to suggest that the present investigation, offering interesting and valuable insight into the medicinal use of plants in a remote part of the Himalayas, reveals previously undocumented ethnomedicinal lore.

**Tom SHAY,** Department of Anthropology, University of Manitoba, 430 Dysart Rd, Winnepeg, Manitoba R3T 2M6, **Margaret KAPINGA,** and **Jennifer SHAY,** Department of Botany, University of Manitoba, Winnepeg, Manitoba R3T 2N2

**BRONZE AGE AGRICULTURE ON THE ARGOS PLAIN, GREECE**

Although a great deal is known about the architecture and pottery of Bronze Age Greece, little is known about its agricultural foundations. This is surprising considering the widely held view that developments in agriculture were responsible for the emergence of Bronze Age civilization. Information about agricultural developments is regrettably scarce because many important sites were excavated

before attention was paid to the recovery and analysis of plant remains. For example, at Mycenae, only grape and olive seeds were recovered through traditional techniques while we, using modern flotation techniques, have found many more seed types at nearby Midea, another key Bronze Age site on the Argos plain. So far, we have analyzed 225 samples, mainly dating to the Late Bronze Age. They contained 1,505 seeds and comprised 14 domesticated and seven wild taxa. Domesticates included cereals (*Triticum monococcum, T. dicoccum, T. aestivum, Hordeum vulgare*), pea (*Pisum sativum*), chick pea (*Cicer arietinum*), grass pea (*Lathyrus sativus*), bitter vetch (*Vicia ervilia*), common vetch (*Vicia sativa*), broad bean (*Vicia faba var. minor*), lentil (*Lens culinaris*), olive (*Olea europaea*), grape vine (*Vitis vinifera*), and fig (*Ficus carica*). Focussing on the role of the chick pea, these results will aid in understanding the nature of Bronze Age agriculture.

**Nancy J. TURNER,** Environmental Studies Program, University of Victoria, Box 1700, Victoria, B.C. V8W 2Y2

**YELLOW AVALANCHE LILY: IMPORTANT INTERIOR SALISH "ROOT" VEGETABLE**

Yellow avalanche lily (*Erythronium grandiflorum*) is a liliaceous "root" vegetable of montane meadows and upland areas of northwestern North America whose bulbs were formerly a staple food for a number of Interior Salish and neighboring Aboriginal groups of the Interior Plateau of British Columbia and Washington. Names for this plant occur in at least eight Aboriginal languages. The taxonomy, ecology, and traditional knowledge surrounding the use of this species are presented. Accounts of traditional use are based on literature sources and interviews with Aboriginal elders of the region. No nutrient data are available, but evidence suggests that the major carbohydrate present is inulin. The bulbs were generally processed for eating or storage by long-term pit-cooking. They are still being eaten in some areas, and in one Aboriginal community attempts are being undertaken to grow them for commercial production. The center of origin for the use of this plant as food seems to be the upland plateaux within Nlaka'pamux (Thompson) and Secwepemc (Shuswap) territories.

**Stephen WENZELL,** Department of Anthropology, University of South Carolina, Columbia, SC 29208

**YALCOBA: A CASE STUDY OF MEDICINAL PLANT USE AND ASSOCIATED KNOWLEDGE IN A YUCATEC MAYA COMMUNITY**

The purpose of this paper is to present the preliminary findings of a pilot project focusing on the use and associated knowledge of medicinal plants in Yalcoba, a Yucatec Maya community. The objective of the study was to record descriptive information about medicinal plants and to investigate the variability in associated knowledge, within the context of an expanding market economy and wage labor system. Data were collected on 19 households concerning knowledge of medicinal plants and inventories were made of "solars" (home gardens). These data have been augmented by health and socio-economic data, collected during the same field period. The relevance of the study is to investigate the

processes associated with changing economic strategies and health care systems in a Yucatec Maya community.

**Wilma WETTERSTROM,** Botanical Museum, Harvard University, 26 Oxford St. Cambridge, MA 02138

**FORAGING AND FARMING IN EGYPT: THE TRANSITION FROM HUNTING AND GATHERING TO HORTICULTURE IN THE EGYPTIAN NILE VALLEY**

The Egyptian Nile Valley was not a center for the independent invention of agriculture. But once farming was adopted here it flourished with the simultaneous emergence of Egyptian civilization. How and why early Egyptians embraced farming has sparked much controversy. The Nile Valley has been seen as a lush forager paradise where hunter-gatherers "resisted" farming until long after it had developed in the neighboring Levant. But in fact the Nile Valley was not a paradise. It had a restricted flora and fauna and its life-sustaining annual floods could vary widely. During periods of high or low or late floods Egyptian foragers, who probably relied primarily on "root" foods and fish, would have suffered food shortages. As a way to buffer themselves against famines and stabilize hunting and gathering they may have incorporated domesticates in their economy. Casual planting of cereals and herding of small flocks would have provided backups during poor years and would have been compatible with foraging and fishing. Indeed, the first evidence of farming in Egypt comes from sites that are little more than forager camps with traces of domesticates—the earliest levels at Merimde in the Delta, ca 4800 B.C., and several small camps in the Fayum ca 5200 B.C.—suggesting that foragers had simply tacked domesticates onto their large repertoire of foods.

The source of the new foods was probably the Levant, as many scholars have proposed, rather than the Sahara, as others have suggested. Early Egyptian crops and livestock occur as a full complex which matches the Near Eastern agricultural complex that was fully developed by 6000 B.C. In addition, domesticates are found first in northern Egypt and make their way south to Upper Egypt about 1,000 years later, suggesting a northern rather than western source. The Near Eastern domesticates probably spread to Egypt between 6000 and 5000 B.C. at a time when farmers were dispersing from the steppic zones of the Transjordon and Sinai as a result of climatic deterioration.

**Elizabeth WING,** Florida Museum of Natural History, University of Florida, Gainesville, FL 32611

**A BRIEF HISTORY OF THE GUINEA PIG**

Guinea pigs *(Cavia porcellus)* were domesticated in the Andes at least as early as 3000 B.C. They were introduced from the center of domestication in the Andes north along the Andean chain and down to the Pacific coast. Their remains are also encountered in archaeological contexts in Venezuela and the West Indies. All Caribbean contexts are either close to the surface or have a mixture of prehistoric and historic cultural material. Some documents indicate that guinea pigs were in

the Caribbean by the time the Spanish arrived. The presence of their remains in mixed contexts further suggest that they were a late prehistoric introduction.

**Melinda ZEDER,** Department of Anthropology, Smithsonian Institution, Washington, D.C. 20560

**INTRA-SITE VARIATION IN MEAT CONSUMPTION AT A MIDDLE MISSISSIPPI VILLAGE IN SOUTHEASTERN MISSOURI**

In the late 1960s and early 1970s, University of Michigan-directed excavations of two Middle Mississippi (A.D. 1300) village sites yielded a wealth of animal bones, plant and wood remains, and artifacts that promised important insights into the organization of village life in emerging ranked societies. Occupied for as short a time as 5–10 years, the Powers Phase Snodgrass and Turner sites in southeastern Missouri seemed ideal archaeological laboratories for examining questions of intra-site social and economic organization. All structures and associated pits at the sites were excavated and the locations of all finds were recorded in hopes that their distribution within these sites would have bearing on the distribution of the activities, the uniformity of access to basic resources by various households, and the connections between households and between different sectors of these sites. Only recently, however, with the development of sophisticated computer mapping and data processing technology has it been possible to tap the true research potential of this unparalleled excavation effort. In 1989, a new phase of research on the material from the Snodgrass and Turner sites began at the Smithsonian Institution under the direction of Bruce Smith. This new Powers Phase project seeks to combine comprehensive studies of the pottery, lithics, botanical remains, wood charcoal, and animal bones with state-of-the-art computer mapping and analytical techniques to accomplish the initial ambitious goals of this precocious project.

This paper reports on results of the analysis of the animal remains from the Snodgrass site. Variations in species distribution, in the quantities of meat represented, and in the representation of different body parts between different households and different areas of the site are examined to better understand intra-village consumption patterns. Also discussed is a detailed examination of bones to distinguish right/left pairs, articulations between elements, and a metric analysis aimed at tracing the trajectory of cuts from individual animals within and between structures at the site.

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# NEWS and COMMENTS

All items for this column should be sent to Gary Martin at People and Plants Initiative, Division of Ecological Sciences, Man and the Biosphere Program, UNESCO, 7, Place de Fontenoy, 75352 Paris CEDEX 07 SP FRANCE. Faxes may be sent to 33.1.44919882. Notes can be submitted on **REQUESTS FOR INFORMATION** in addition to the sections included below. Because the *Journal* is published only twice a year, dated items must be received at least six months in advance of the event.

## COMMENT

**OTHER WAYS TO MAKE MAPLE SUGAR** by Margaret B. Holman, *Michigan State University Museum, East Lansing, MI 48824*

The argument from technology has long been part of the controversy over who invented maple sugaring (Yarnell 1964:78; Nearing and Nearing 1970; Pendergast 1982). The question of the adequacy of prehistoric technology for sugaring is critical. If you can prove prehistoric Native Americans could not make sugar, then you can conclude they did not. Yet with time and technological change, we are now even less able to evaluate descriptions of sap processing with prehistoric technology than were late seventeenth and early eighteenth century authors such as Charlevoix (1966:192), LaHonton (1905:366), and Lafitau (1724). Thus, Patrick J. Munson's recent attempt to make maple sugar by stone boiling syrup (Still more on the antiquity of maple sugar and syrup in aboriginal eastern North America. Journal of Ethnobiology 9:159–170. 1989) is a useful contribution questioning arguments that prehistoric Native Americans could make maple sugar by this method (Nearing and Nearing 1970; Holman and Egan 1985).

Munson's (1989:165) experiments changed maple syrup by stages into a carmelized, a charred, and finally, a dark and bitter mass. These results cast doubt on the suitability of stone boiling during the later stages of making sugar. I believe however, there is evidence that people could make various kinds of sugar, as opposed to syrup, *without stone boiling*. I also believe that Munson's (1989:167) distinction between the different maple products, i.e., syrup and sugar, coupled with the results of his experiment may have ramifications for considering the geographic distribution of prehistoric "sugaring."

Munson (1989:165) reasons that while containers available to prehistoric peoples, i.e., ceramics and birch bark, may have been adequate for making maple syrup (Holman and Egan 1985), they do not seem to have been suitable for making maple sugar. They could not withstand the additional heat needed to make syrup into sugar without use of hot stones. I concur with Munson's views regarding ceramic containers, i.e., that while they are suitable for boiling water for cooking and for boiling sap to make syrup, the intense heat required to maintain

syrup at a rolling boil for making sugar probably would require stone boiling to achieve the proper temperatures. I don't know whether pottery could withstand the stirring and scraping required to achieve granulation and prevent scorching as Munson suggests (1989:166).

I still believe, however, that birch bark containers could have been used for prehistoric sugaring. It is true that Egan and I (1985) only made syrup in birch bark and did not process the syrup into sugar. Thus, I cannot speak from experience. There are enough ethnohistoric and ethnographic documents from disparate sources however, that can be used along with oral history and museum specimens to support my position that: (1) sugar can be made in birch bark without stone boiling, (2) birch bark was not too flammable to be a reliable container, (3) birch bark is strong enough to withstand the stirring required to prevent scorching and to hasten granulation, (4) syrup can be beaten and stirred to make granulated sugar in containers of wood or other materials, regardless of whether the boiling container was of bark or metal, and (5) birch bark containers can be made large enough to process a suitable quantity of sap.

The sources used here are part of a wider body of similar material describing sugaring in different regions by varied ethnic groups. They serve as examples used to address the question resulting from Munson's (1989) experiments, i.e., what is the feasibility of making granulated maple sugar without metal containers and without stone boiling? Documents, museum specimens, and oral history indicate there are nonmetal materials and processing techniques, other than stone boiling, that can be used to produce a variety of maple products, including, but not limited to, granulated sugar. Nonmetal containers suitable for sugaring were available prehistorically in various parts of North America. Whether prehistoric peoples *actually* made sugar or other maple products is not answered by the evidence. Rather, by indicating alternatives to stone boiling, the *feasibility* of prehistoric sugaring remains.

The most explicit first hand account of sugaring in birch bark comes from the recollections of Thomas P. Wentworth who grew up in the Minnesota country in the 1830s (Armstrong 1892). Wentworth states that syrup was made by evaporating the sap in a birch bark kettle suspended over the fire from a tripod (Armstrong 1892:111–112). Sap was added to the kettle as the liquid content decreased by evaporation. The resulting syrup was placed into a second, tray-shaped, birch bark container which was hung over the fire with basswood fiber at each of the four corners. The contents of this bark tray were stirred with a wooden paddle to prevent scorching and then placed into rock bowls where it was granulated.

This technique of moving sap from one container to another, usually with a ladle, is common also in descriptions of "sugaring" with metal kettles (Nearing and Nearing 1970:55; Densmore 1974:311). By this means the process is continuous and avoids the necessity of making one batch of syrup and/or sugar and then starting on another. Rather, the raw sap is added to a small container and then transferred to a larger one as it nears the syrup stage. Modern evaporators likewise work on this principle. They are partitioned so that the raw sap enters one end and the finished syrup is emptied at the other end. In this way neither sap nor time is wasted and scorching is kept to a minimum.

Edward Pine, a Chippewa who lives in Michigan's Upper Peninsula, has been

making maple syrup and sugar for over fifty years. He has never made either product in birch bark, in part because lumbering has taken the large birch trees needed for containers. His grandmother, however, did make syrup and sugar in birch bark and described the process to him. The vessels used to evaporate the sap measured about 2 ft × 2 ft × 1 ft and were thus tray-like in shape. She used stones to heat the sap, but did not put them into the container. Rather, she put them under it to provide the heat. She specifically recommended the use of blue and red stones.

This method of using stones under the vessel may have advantages over placing the container above hot coals (Holman and Egan 1985:64) as it may be easier to regulate the heat. It would also be added insurance that the bark would not directly contact fire. Mr. Pine reiterated the reports of authors such as Wheeler (1844), Densmore (1979:41), and Gidmark (1980:51) who state that so long as you have liquid in a bark container, it will not burn. Egan and I did lose a bark kettle to fire during our experiments (1985:66) because there was a flap of bark which was not tacked down. This flap did not contain sap, came into contact with flames, and burned. Experience in working and cooking with birch bark would have prevented this problem.

Munson (1989:161) notes that when syrup is concentrated by boiling to a 98–99% sugar content the boiling temperature is ca. 121°C (250°F). This is about 20°C (40–45°F) higher than the boiling point of sap with a 2.0–2.5% sugar content (100°C, 210–215°F) or syrup with a 65% sugar content (104°C, 219°F). He argues that in order to make sugar within a reasonable length of time, a rolling boil must be maintained and that the increased heat would also increase the danger of burning a bark container (Munson 1989:165).

According to Mr. Pine, there is really no need to increase the heat to a critical temperature during sugaring, since as long as steam is present above the sap, evaporation is occurring. This is in accord with our own observations. During our experiments, the only time the sap actually reached a rolling boil was when we added stones. The sap in one bark container to which no hot stones were added did evaporate, however. This sap approached the syrup stage with a 58.7% sugar content in one hour less than sap in a bark container to which stones were added late in the process (Holman and Egan 1985:66). The latter, partially stone-boiled sap evaporated to a sugar content of 61.46%. By contrast, sap in ceramic vessels that was kept at a rolling boil by adding hot stones reached a sugar content of 18.9% and 49.6% in the same amount of time. The crucial difference was not in maintaining a rolling boil, but in the shape of the containers. Evaporation of sap into sugar can thus be accomplished without boiling. It is noteworthy that the bark container in which Wentworth heated syrup prior to making sugar was also tray-shaped (Armstrong 1892:112).

Densmore (1974:312) describes the initial stage of "sugaring off" as a process by which strained and cooled syrup was placed in a kettle and heated *slowly*. As the syrup heated, it was stirred with a wooden paddle, but the hard beating to achieve granulation was done not in a metal kettle (Densmore 1974:312), or in a birch bark tray (Armstrong 1892:112), but in a granulating trough. Native Americans and settlers alike granulated their sugar by beating and stirring it in a wooden bowl (Svoboda 1964), a maple node or burl (Kohl 1956:183,184), or a stone

bowl (Armstrong 1892:112). An example of a wooden granulating container used by the Ottawa is on display at the Field Museum in Chicago (#96951). Other forms of sugar were hard cakes made by pouring hot syrup into molds of wood or clam shell (Field Museum #34766.1,34760.2) or wax/taffy made by pouring the syrup onto snow or sheets of bark (Jenness 1977:44). As noted by Munson (1989:164), neither the hard cakes nor the taffy require beating.

Finally, birch bark containers sizeable enough to process quantities of maple sap can be made without adding other supports such as ribs used to reinforce a canoe (Munson 1989:165). Birch bark makuks and buckets have a strip of wood sewn around the top to maintain the vessel shape (Wheeler 1844; Densmore 1974:314). Quite large containers can be made in this way. Bark sap collecting buckets, comparable in size to modern pails, are strong enough to hold and transport several gallons of liquid. Bark buckets were commonly used by Native American sugar makers into the twentieth century (Densmore 1974:309; Rogers 1974:33–40). According to Peggy Hemenway, a Traverse region Ottawa who works with birch bark, makuks for storing a years supply of sugar can be made from 3–5 ft tall. Densmore (1974:210) reports these makuks can hold up to 100 lbs of maple sugar. Khol (1956:319) observed that such large makuks were a regular household item in the Lake Superior region. They were placed in the lodge to be within reach when sugar was needed. The limiting factor in cooking with birch bark is neither size, strength, nor flammability. The real constraint is in the use life of a bark cooking container. While makuks, buckets, and baskets may last from five to ten years (Densmore 1974:310), a cooking container may be used only once (Wheeler 1844).

Given the limited durability of bark cooking containers, it is reasonable to address Munson's (1990, personal communication) question, "Why use birch bark?." The answer may lie in its relative availability in remote settings. It is noteworthy that most references to people cooking and sugaring with birch bark come from sparsely settled regions such as northern Michigan, Wisconsin, Minnesota, Quebec, and Ontario, and are from the nineteenth and early twentieth centuries (e.g., Armstrong 1892; Jenness 1935; 1977). Photographs of Native Americans making maple syrup and sugar show them using metal kettles, but also depict the use of wash tubs and other similar containers to boil sap (Densmore 1979:41,125). Durable bark collecting troughs, buckets, and makuks continued to be used for a long time after their metal counterparts were known (Densmore 1974:309;1979:123). As noted by Mr. Pine, metal for sugaring technology only became necessary when the large birch trees were destroyed by lumbering. Thus, until this century, Indians from the northern forests were able to make their sugar in containers made of different materials. They could choose between factors such as availability of a sufficient supply of metal or birch bark, durability of metal in comparison to birch bark, relative efficiency of different shaped containers of each material, and cost of procuring containers of metal or bark. Such choices are not always obvious. For Mr. Pine, sugaring is a tradition that includes boiling sap in his grandfather's metal kettle. The kettle is a priceless part of that tradition and he would not consider using an evaporator to make more syrup and sugar in less time.

Evidence from varied sources indicates that it is possible to make maple sugar using prehistoric technology and that some people did so long after metal kettles

were available. Thus, the argument from technology, that prehistoric Native Americans were unable to make maple sugar, is not proved. They could make sugar.

By showing how sugar was *not* made, Munson's (1989) experiments contribute insights into what technological alternatives for sugaring were available to prehistoric Native Americans. For example, since birch bark is a product of northern forests, while ceramics have a much broader distribution, Munson's (1989) results imply the possibility of geographic differences in the processing of maple sap into various products. Whether people living outside the northern forests had containers of other materials that could be used to process sap into sugar without stone boiling is not known. These populations did have the option of making syrup, however (Munson 1989).

Documents, oral history, and museum specimens describe and illustrate the processing of maple sap without European materials. This evidence implies that the technology for making maple syrup and sugar using nonmetal materials and various techniques was quite flexible and *could* have been employed prehistorically. Many accounts are not explicit about each step in the process or about materials comprising each implement used, however. Thus, even though stone boiling was mentioned as a way to boil sap (e.g., Keating 1824), it is not necessarily true that *all* steps in processing sap into sugar were accomplished by stone boiling. Similarly, Armstrong's (1892) description of sugaring with birch bark identifies the material of the "kettle" used. The term kettle here describes the shape and function of the container, *not* its material. Yet we automatically picture a metal container whenever we read the word kettle. These limitations of the historical evidence become greater with time and technological change. We are in the position of a sophomore student in the MSU Museum lab who held up a rusty object to be identified. It was obvious to her (only slightly) older coworkers that this historic artifact was a skate key and they were chagrined to have to explain its use. Munson's (1989) experiments with stone boiling maple sap help us to understand prehistoric sugaring technology in ways that cannot be gained from other kinds of evidence. We cannot imagine life without metal and thus, it is hard for us to discern the technological possibilities of the prehistoric environment.

Since these comments have been in press, I had the opportunity to observe the production of sugar from syrup in replicas of prehistoric pottery. Frank Ettawageshik, a professional potter who produces ceramics using prehistoric materials and techniques, and Jon Cowan of the Chippewa Nature Center in Midland, Michigan, conducted controlled experiments in which syrup was boiled in a pot surrounded by coals. When ready, it was transferred to a wooden "sugar boat" and granulated with a wooden ladle. No stone boiling was done in these experiments. The results are being prepared for publication by Ettawageshik and Cowan.

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## COMMENT

**STILL MORE ON MAPLE SUGAR: COMMENTS** by Carol I. Mason, *University of Wisconsin–Fox Valley, Menasha, WI 54952*

The old debate over the origins of maple sugaring has recently been refired thanks to imaginative and provocative attempts by archaeologists to discover a role for sugar calories in prehistory (Holman 1984, 1986; Holman and Egan 1985; see also Mason 1986, 1987 for objections). The most recent discussion of the problem has been Munson's re-examination (Still more on the antiquity of maple sugar and syrup in aboriginal eastern North America. Journal of Ethnobiology 9:159–170. 1989) of the old argument that aboriginal technology was inadequate for sugar making—the "argument from equipment"—and, further, that ambiguous references in the early historic literature refer not to sugaring but instead to making *syrup*.

The argument from equipment has been tested in recent years through several replication experiments that in the end have strongly supported its original contention, i.e., without European tools and techniques, aboriginal maple sugaring was impossible. The earliest of these was an effort by Holman and Egan (1985) *supporting* sugar use in prehistory. They wanted to understand how syrup

—and by implication, sugar—might be produced using procedures mentioned in historic sources or suggested from a knowledge of aboriginal equipment. They were able to produce syrup of near USDA standards in birchbark trays or clay vessels by means of stone boiling, over direct heat, or a combination of the two. Only the birchbark trays were stout enough to be put over direct heat, but they burned easily unless placed over coals rather than an open fire. In all their experiments 5–6 hours of boiling were necessary to achieve a concentration that could be described as "syrup." In one case they tried freezing sap in order to concentrate it before boiling and were able to double the sugar content of raw sap from 3% to 6% (Holman and Egan 1985:65). This was not enough, however, to demonstrate the usefulness of this as a technique for making syrup, even though one source (Smith 1831) mentioned that sugar itself might be produced this way. Holman and Egan's experiments showed clearly that syrup could be made with simple equipment as long as the producers had enough time, fuel, and energy to persist in a tedious and labor-intensive task. On the surface, they had put to rest the argument from equipment or at least that part of it pertaining to syrup. The larger problem, sugaring, proved to be the sticking point.

Munson (1989) has carried the replication experiments of Holman and Egan a step farther in an attempt to produce sugar through similar means. His results support a view that making sugar is not simply a process of evaporating sap to a point where it suddenly becomes sugar; his experience indicated that a greater intensity of heat had to be applied as the sap approached sugar conversion. Further, the hot syrup had to be scraped, paddled, and vigorously beaten as it cooled in order to produce a useable, granular-textured product (Munson 1989: 161). His conclusion was that none of the containers known historically or archaeologically was sturdy enough to withstand such treatment. Munson further attempted to reach sugaring temperatures through stone boiling a 65% sugar syrup. He discovered that at high temperatures his hot syrup carmelized on the stones used for boiling, and eventually burned, leaving a residue that was bitter rather than sweet and certainly not sugar (Munson 1989:165). His conclusion was that while syrup might be made by stone boiling, sugar could not. The argument from equipment—at least as far as maple sugaring is concerned—has been sustained until, of course, future replication studies involving specific kinds of prehistoric containers are conducted.

Munson's arguments that precontact people actually made syrup rather than sugar, however, require closer scrutiny. These are based squarely on linguistic data that he considers sufficiently strong to indicate that *something* involving maple products occurred in precontact times. Since his own replication experiments will not support sugaring, he feels the only alternative is the use of sap boiled down into syrup. He backs this suggestion with information from folklore, the Holman and Egan experiments, and some historic sources that reinterpreted from this point of view seems to offer support. He makes the point that few others considering the maple products question have addressed the issue of syrup as something distinct from sugar, and he feels that failure to distinguish between the two would account for some of those odd historic references to a maple drink that seems too sweet or too dark or too much "like wine" to refer solely to unprocessed maple sap (Munson 1989:167–168).

Linguistic data have been considered important support for precontact sugaring for a long time. Both Henshaw (1890) and Chamberlain (1891) were impressed by philological evidence for the antiquity of a maple products industry; Henshaw in particular gathered together a list of terms that supported his contention. He felt that if Indian terms for European sugar were the same as those for homegrown maple sugar, this would be strong support for maple sugar's being antecedent to an acquaintance with European sugar. Indians would have simply used the preexisting term to apply to the new but clearly related sweet substance. Furthermore, if those Indian terms for sugar came from the name for the maple tree itself, this would be further evidence that "maple sugar was a truly aboriginal production" (Henshaw 1890:349). All the terms for maple sugar that he was able to gather together refer to tree sap in one way or another with etymologies pointing to the fact that the sugar had its origin in the sap. Munson has carried Henshaw's linguistic analysis a step further by expanding the comparative sample of source languages (Munson 1989:163). In six Siouan, three Iroquoian, six Algonkian, and one Caddoan language, the word for "maple sugar" is an indigenous one, completely free from any expressions borrowed from European languages. Agreeing with Henshaw, Munson interprets this as strongly supporting the precontact use of some kind of maple products.

The linguistic data, however, are open to more than one interpretation. When translated into nearest English equivalents, the word used in all the cognate languages means only "wood water," "wood sap," "from wood," "tree water" or the like (Henshaw 1890; Munson 1989:Table 1). In no case does the term *describe* anything processed, syrup or sugar, even though in postcontact times it was specifically applied to the solid maple sugar. It can be argued that this is a plain case of the broadening of meaning, an older term extended to new things. In modern American English, for example, the word "corn" applies to *Zea mays;* the fact that English speakers in Europe used the word "corn" in pre-Columbian times does not imply the presence of *Zea* there. The term has simply acquired a new meaning. In the case of maple products, the unanimity of the meaning of references to tree sap or wood water—not sugar or syrup—argues for sap's being the only pre-Columbian product from maple trees. When Native Americans learned about sugaring, they used the in-place word to describe it, consciously making the link between the sap of origin and the sugar of production. It is an unnecessary complication to interpret a straightforward expansion of meaning as anything more than that.

Munson also finds part of the argument from equipment, i.e., that syrup can be produced in birchbark containers and clay pots, sufficient reason to suppose that it was. Holman and Egan's (1985) demonstration of the efficiency of such containers in making maple syrup is still not the same as demonstrating that pre-Columbian people did likewise. After all, paddling a bark canoe across the North Atlantic is "feasible," but accomplishing the voyage would not demonstrate that American Indians did so in prehistory.

Munson's argument concerning oral traditions and folklore is still another line of reasoning that requires close and careful scrutiny. He considers statements in such sources about manufacture of ancient maple products as "noteworthy" (Munson 1989:162) support for his position, but as he points out, they are *all* too

late to be trustworthy. Some of these speak of Native Americans making sugar before Europeans arrived using technology that Munson himself has demonstrated to be ineffectual. How he decided that the mention of sugaring really indicates the presence of syruping in epistemologically suspect accounts is not clear. Oral traditions and folklore collected in the nineteenth century cannot provide confirmation of a practice carried on hundreds of years before the folklore was collected. These same tales include references to guns, horses, and European supernatural stories, and until there is a way of distinguishing what is syncretism and what represents the original pristine condition, folklore, no matter how suggestive, is a tainted source of information.

The usefulness of maple syrup as food for the end of winter-early spring "starving" time is also cited as a support for its presence in prehistory (Munson 1989:167). It is reasonable to suppose that any useful food would be consumed by people in need, but there is no historic documentary evidence to indicate that syrup was made by those suffering from hunger. It might be proposed, as Munson does, that such an activity would not be seen by European observers except by chance. Europeans were interested enough in such foods that they collected information on plants such as lichens and slippery elm bark, among others, and commented on the difficulties of the "starving" time. Absence from these lists is more likely to have been because the foods in question *were* absent, not that Native peoples consumed them in private. Secret consumption can never be disproved, of course, but it seems an unnecessary complication to the issue. In any case, the use of maple syrup as a late winter food begs the question of how much energy would have to be expended in production as opposed to the energy derived from it as a source of calories.

The historic sources that Munson cites as supporting his contention that syrup was present at contact and in prehistory are better treated as "meaning what they say" rather than subjecting them to exegesis. He makes a point that comments by French observers on the sweetness of sap are hardly warranted and that for sap to have tasted so sweet, it must have been processed, i.e., turned into syrup (Munson 1989:168). He is, however, projecting the sugar-saturation of modern tastes back into the sixteenth and seventeenth centuries, when sugar of any kind was much rarer. Cartier's enthusiasm, Lescarbot's pleasure, and Le Jeune's reports of sweetness (Munson 1989:167–168) reflect more the sugar-free condition of the times, not an assessment of the presence of maple syrup. And finally, Munson's (1989:168) reference to Denys, which he considers a major support for the presence of syrup, is not that at all. The segment of Denys that he cites as referring to maple sap's being used to "make" a beverage ("There is made from it a beverage . . .") goes on, as cited in Schuette and Schuette (1935:210), to specify that the beverage was "made" by letting it run out of gashes in a tree, not by cooking it up, boiling it down, or otherwise processing it.

Munson is premature in separating sugar and syrup and plugging for the latter in prehistory. The historic data are not supportive, the linguistic data are capable of other interpretations, and arguments from folklore are unacceptable. In the matter of maple products in prehistory, Munson's own work has apparently strengthened the verdict against prehistoric sugaring, but his case for making syrup is unconvincing.

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## RESPONSE

**THE ANTIQUITY OF MAPLE SUCROSE CONCENTRATES: REPLY TO HOLMAN AND MASON** by Patrick J. Munson, *Department of Anthropology, Indiana University, Bloomington, IN 47405*

For 300 years scholars have debated, and have been divided on, a subject that on the face of it seems to pose a simple question: Did, or did not, the Native American populations of eastern North America produce maple sugar prior to the ready availability of European technology, specifically the metal kettles that were acquired in quantities by about 1675? The preceding comments by Holman and Mason are not only the latest contributions to this longstanding debate, but also reflect the diametrically opposed positions. In my 1989 article I attempted to reconcile the two sides of the controversy by arguing that both might be partly right, and partly wrong (Munson 1989). Specifically, although there are no data that support the position that maple sugar (as a solid) was manufactured prior to 1675, there are, nevertheless, numerous and diverse lines of evidence that "liquid sugar" (i.e., maple syrup or an approximation of it) was produced long before that date. My reward for this attempt at mediation has been to be assailed by both camps.

Holman, in an extension of an earlier experimental study that demonstrated that maple syrup could be produced with traditional technologies (Holman and Egan 1985), here demonstrates with ethnographic data that actual sugar can be manufactured with birch bark containers. This is very interesting, and *if* it should ever be documented that Native Americans living prior to 1675 did produce sugar it will serve as a valuable demonstration of how sugaring might have been accomplished. But an unintended result of Holman's study is that it supports my explanation of why sugar was *not* made prior to the availability of metal kettles; it is a

difficult, time-consuming, and "attention-intensive" task to produce even small quantities of sugar by this method.

Furthermore, and more importantly, in regard to the question of the antiquity of maple sugar manufacture, it really doesn't matter whether sugar can be produced with non-Western equipment. Sugar is easy to transport and easy to store (as well as very tasty), and if it was produced prior to 1675 it seems inconceivable that it would not have been transported from camps to larger villages and there have come to the attention of European observers, many of whom were by this time long-term residents among Native American groups. That nothing that can be construed as maple *sugar* is mentioned by the numerous early observers constitutes very strong negative evidence that sugar was absent prior to 1675. This position was first argued by Ganong (1910:123, footnote) and subsequently by Mason (1985, 1986, 1987).

Mason and I agree on the absence of maple sugar prior to 1675. Where we diverge, however, is on her insistence that prior to the manufacture of actual sugar the only use of maple products was the occasional drinking of unaltered sap. To be sure, maple sap was drunk, by both Native Americans and early Europeans, who found that it was "exceeding cooling and refreshing, and leaves on the palate a certain flavour of sugar" (Charlevoix 1761:192). Maple sap is usually 2.0–2.5% sugar (occasionally 3.0% for early season runs). At these sugar concentrations, maple sap has very little food value; to supply 2,000 calories would require the consumption within a 24-hour period of 14–17 l of sap. This is the volumetric equivalent of 39–49 12 oz. (354 ml) bottles of beer. I am being only partially facetious in suggesting that the diuretic effect of consuming this much maple sap would probably outweigh the caloric benefit. Concentration of the sugar content to 10–20% (which results in a noticeably sweet and brownish liquid) reduces the volume of 2,000 calories to a manageable 2–4 l.

Assuming that it was feasible to produce "syrup" of these or higher sugar concentrations with Native American technology, and given that maple sap is available at a season when there are few other food resources, it seems very plausible that syrup was produced long before the availability of metal kettles. But, as I've argued previously, one needn't depend simply on arguments of plausibility for the pre-1675 presence of syrup manufacture. There are diverse and independent data from early historic written sources, oral histories, linguistics, and experimentation that support the position that some kind of maple syrup was produced by Native Americans long before sugar was manufactured. In her comment Mason concludes that these data are "not supportive," "unacceptable," and "unconvincing." In the remainder of this paper I will again examine these data-sets, as well as Mason's objections to them.

The most relevant, or at least the most specific, early historic documents pertaining to the use of maple products include (1) comments by Thevet in 1557, who in referring to either the Cartier or Roberval expeditions to Canada in 1535 or 1543 stated that a drink made from the sap of a tree had a taste "resembling that of the good wines of Orleans or Beaune" (quoted in Pendergast 1982:33); (2) Le Jeune's observation in 1634 that the Montagnais got from a certain tree "a juice, sweet as honey" (Thwaites 1959:273); and (3) Denys' comment that in the period 1632–68 the Micmacs made from the sap of maples a sweet beverage "of the

colour of Spanish wine but not so good" (Ganong 1908:380). In an earlier article, Mason dismissed the comparison with the taste of wine by suggesting that "their memories of French wine were fading" (1987:101). Was Le Jeune's memory of the taste of honey also fading, as well as Denys' eyesight?

The comparison of the taste of the beverage to honey is straightforward, but the comparison of the color to "Spanish wine" requires some explanation to demonstrate its significance. In the sixteenth and seventeenth centuries, *vin d'Espagne* was a common appellation for Malaga, also known as Spanish Mountain wine and *malvoisie d'Espagne* (Roquefort 1815:50, footnote; Earl of Belmont [1699] quoted in Allen 1974:463; Robert 1985:200). Because this sweet, fortified wine is made from the juice of partly dried Malvasia grapes and is "cooked" in oaken casks, it has a distinctive brown color (Schoonmaker 1980:216). Unaltered maple sap is "tolerably clear, tho' somewhat whitish" (Charlevoix 1761:192); it must be evaporated to a sugar concentration of at least 15–20% before its color approximates that of the most pale varieties of Malaga.

The next relevant comments on the use of maple products prior to 1675 are from English sources, the most explicit of which was published in 1685:

> The Savages of Canada, in the time that the Sap rises, in the Maple, make an Incision in the Tree, by which it runs out; and after they have evaporated 8 pounds of the liquor, there remains one pound as Sweet, and *as much Sugar,* as that which is got out of the Canes . . . (Anonymous 1685:988, emphasis added).

To appreciate the importance of this statement, note that maple sap is a 2.0–2.5% sugar solution. Evaporation of seven-eighths of sap results not in sugar but rather a 16–20% sugar solution. Such a concentrate is very close to being "as much sugar" as the juice of sugarcane, which is about 14% sucrose, plus minor quantities (< 1%) fructose and glucose (Van Hook 1949:26).

Clearly what this observer was saying, both by the explicit reference to an 8-to-1 reduction and by the comparison to sugarcane juice, is that the Indians were producing a thin syrup. And the statement is followed by: "The Savages here have practiced this Art longer than any now living among them can remember. There is made with this Sugar. . . ." (Anonymous 1685:988). Assuming that some of those living in 1685 were 75 years of age or older, this places the "art" of making the concentrate back to at least the early decades of the seventeenth century.

A similar, although briefer, account was written in 1684 by a Dr. Robinson, who stated that sugar was made from the "juice of the wounded maple . . . in Canada, . . . eight pints [8 lb.] yielding commonly a pound of sugar. The Indians have practiced it time out of mind . . ." (cited in Schuette and Schuette 1935:211). This 8-to-1 ratio must refer either to a 16–20% sugar solution or to solid sugar that was produced from a "juice" that was already a 12.5% sugar concentrate.

Thirdly, on the authority of Robert Boyle (1664:102) and as was confirmed to him "upon his own knowledge" by the agent of the Colony of Massachusetts, there was in "New England, a kind of Tree . . . whose juice, . . . if it be permitted slowly to exhale away the superfluous moisture, doth congeal into a sweet and saccharine substance." One cannot determine from this who was making precisely what, but nevertheless it is undeniable that more than a decade prior to

1675 someone in northeastern North America was aware that some kind of sweet substance could be produced by evaporating sap.

The latest of the historical documents directly pertaining to the pre-sugar era are the some comments by Charlevoix. He was convinced that the making of actual sugar was a relatively recent development, but he was equally convinced that before sugar was made the Indians "have at all times" used maple sap, but "were satisfied with giving it two or three boilings, in order to thicken it a little, and to make a kind of syrup *(espèce de Sirop)* from it . . ." (Charlevoix 1744:180; 1761:192). Although it is not clear precisely what "boilings" *(bouillons)* mean quantitatively, they were sufficient to concentrate ("thicken") the sugar content. And before it is argued that the late date of this document makes it mere "folklore," let it be noted that although not published until 1744 the statement was made in a letter that Charlevoix wrote in 1721 while he was among the Abnaki during the sugar season. At that date, only 46 years after the first reference to maple sugar, there should have been numerous informants who had witnessed activities in the pre-sugar era.

Mason argues that the early historic sources "are better treated as meaning what they say. . . ." I agree wholeheartedly, for what they say is that substantially prior to the availability of metal kettles the Indians of northeastern North America were evaporating maple sap to produce a kind of syrup that was similar in color to Malaga wine (implying, minimally, a 15% sugar concentration), or eight times sweeter than maple sap (i.e., 16–20% rather than 2.0–2.5% sugar), or comparable to sugarcane juice (about 14% sugar).

Although many of these early sources indicate that the concentrations were achieved by evaporation, they do not specify how this was accomplished. It is for this reason that I (and others) have found the tradition recorded in Keating (1825:114–115) of particular interest, for it is an explicit description, from a Kickapoo chief, of stone-boiling maple sap in log troughs in the era before metal kettles were available. Mason summarily dismisses this "tale" (her term) on two counts. Her first argument is that it was recorded far too late to be reliable for activities conducted prior to 1675. However, although not published until 1825, the account was collected some years before this date, and we do not know the age of the Kickapoo informant. If he were elderly, then it is plausible that he was repeating statements that were made to him as a child or young man by persons who were alive before 1675.

But Mason objects further that the Kickapoo tradition refers to making *sugar* by stone-boiling, pointing out that I had concluded from my experiments that making actual sugar would be very difficult, if not impossible, by this technique. However, she has neglected to heed another point that I stressed, namely that with very few exceptions persons speaking or writing on the subject of maple products have failed to make a distinction between actual sugar (the solid) and syrupy sugar solutions, or have confused them. Mason herself is guilty of committing this error (see below).

Boiling is not, however, the only way in which maple sap can be concentrated to sugar levels that are plausible for its use as a foodstuff. If weather conditions are appropriate, partial freezing and discarding of the ice is a practical technique for achieving sugar concentrations appreciably greater than 2.0–2.5%. By first

freezing off part of the water and then boiling the resulting concentrate one can greatly increase efficiency in making syrup. However, Mason dismisses the importance of this technique on two grounds. First, referring to Holman and Egan's (1985:65) experiment with freezing sap, she notes that they only doubled the sugar concentration (3%–6%). That is the result they achieved by allowing the sap to freeze *for one night*. But if they had allowed the resulting 6% solution to freeze the next night, with similar temperatures the unfrozen part would have had a sugar concentration of 10–12% (and a food value of 571–685 calories per liter). Additionally, Mason overlooks that whereas the reduction of the volume of water from maple sap by boiling is an arithmetric progression, the resultant increase in the percentage of sugar is geometric, or nearly so: the differences in boiling temperatures and specific gravities between water and sugar cause minor deviations as the sugar proportion increases. For example, with heat and surface area constant, if it requires one hour of boiling to reduce a given quantity of sap to half its volume (i.e., to increase a 3% sugar solution to 6%), then it requires only another 30 minutes to reduce the remaining 6% solution to half its volume, or 12% sugar, then only 15 minutes more to achieve 24%, and so on. Consequently, if one's goal was to convert 3% sap to 65% syrup, then the nearly effortless technique of allowing the sap to freeze and discarding the ice to achieve a 6% solution results in a savings of about 53% of the time (or energy) that would be required if boiling alone was used. Mason is simply wrong when she states that experiments in freezing sap have shown that the advantages are "not enough . . . to demonstrate the usefulness of this as a technique for making syrup."

Further, Mason asserts with regard to freezing sap that "one source (Smith 1831) mentioned that sugar itself might be produced" by freezing maple sap. I presume that the intent of this statement is to cast doubt upon the relevance of freezing and/or the reliability of this important early observer—sugar cannot be made by this technique (about 18% is the maximum possible concentration). But Smith neither said nor implied that *sugar* was produced by freezing; rather he refers to the production of a syrup-like sugar concentrate. Specifically, in the spring of 1757 his Huron captors:

> . . . made the frost, *in some measure*, supply the place of fire, in making sugar. Their large bark vessels, for holding the stock-water, they made broad and shallow; and as the weather is very cold here, it frequently freezes at night in sugar time; and the ice they break and cast out of the vessels. . . . I observed that after several times freezing, the water that remained in the vessel, changed its colour and became brown and very sweet (Smith 1831:69–70, emphasis added).

Yet another nearly passive way of making liquid concentrates with non-Western technology has been recorded from elderly and traditional Ojibwas, who stated that in former times they thinly spread maple sap on large sheets of birch bark "where the warm sun hardened it to a consistency of treacle [molasses] . . ." (Jenness 1935:13).

Mason also attacks my conclusions on the basis of the results of experiments in making syrup-like sugar concentrates with Native American technology. Here her objections rest squarely on the experiments by Holman and Egan (1985),

whose results lead her to question the cost-efficiency of the "tedious and labor-intensive task" of producing maple syrup with precontact equipment. Holman and Egan utilized various combinations of stone-boiling and direct heating in very small (1.9 l) birch bark and ceramic vessels to produce syrup. Working together for about 6.5 hours (13 person-hours), they were able to reduce 17.3 l of 3.25% sugar solution (part of their sap had been previously somewhat concentrated by freezing) to syrup with an average sugar concentration of 47.6%, or an output of 250 calories per hour. This is clearly a very low return. However, several things are to be noted in regard to these experiments: (a) in addition to simultaneously conducting five experiments with traditional techniques (one of which failed catastrophically and another proved very inefficient), they also boiled sap in two metal kettles; (b) they were, as they quickly realized, badly under-equipped in regard to numbers and sizes of birch bark and ceramic containers; and (c) they were rank novices in using the techniques. Had they confined their efforts to only one of the more efficient precontact techniques, and had adequate equipment and more experience, I think that their productivity would have tripled (i.e., to 750 cal/hr). Further, if the experiment had been stopped when the percentage of sugar reached 15% (comparable to concentrations suggested by early historic sources) rather than continuing to 47.6%, then the required processing time would have been reduced by one-sixth, thus increasing the yield to 907 cal/hr. Alternatively, if all of the sap, rather than only part, had been concentrated to 6% sugar by freezing prior to boiling, then the 47.6% sugar level could have been achieved in less than half the processing time, producing a yield of 1,569 cal/hr. Combining these two (concentrating to 6% by freezing and boiling to 15%) reduces the time requirement by more than two-thirds, with a resultant output of 2,381 cal/hr.

Some perspective on these yields (750–2,381 cal/hr) can be gained by comparison with the cost-efficiency of processing another natural product. Several experiments in extracting nutmeats from wild black walnuts with precontact techniques have resulted in yields ranging from 628–824 cal/hr (96–126 gm nutmeats) (Reidhead 1981:187; Talalay et al. 1984:384). I presume that Mason is not prepared to argue that the processing costs are so high that pre-1675 Native Americans did not utilize black walnuts as a foodstuff.

Lastly, there are the implications of the linguistic data pertaining to maple products, where in all four language families of northeastern North America the terms for sugar (i.e., a solid) refer to it as a liquid. Mason finds no problem with a conceptual leap and terminological transfer from barely sweet maple sap to solid sugar, nor for these processes occurring nearly simultaneously among groups as linguistically and geographically separated as the Iroquoian Tuscarora of North Carolina, the Algonquian Micmac of Nova Scotia, and the Caddoan Pawnee of Nebraska. I find it much more plausible that the original (and widespread) use of maple products was as a concentrated sugar solution (i.e., a syrup or similar product), and that when the technology or knowledge appeared that made it feasible to convert this concentrate to actual sugar the terms for "liquid sugar" (i.e., syrup) were transferred to the solid.

In summary, for more than 80 years various scholars have pointed out that there is overwhelming negative evidence that maple sugar was not produced prior to about 1675. Holman's ethnographic and experimental data notwithstand-

ing, this verdict still stands. But in previous articles, Mason has taken the position a step farther, insisting that prior to the manufacture of actual sugar the only use of maple products by Native Americans was the occasional drinking of unaltered sap. In an 1989 article I argued, on the contrary, that there are abundant and diverse data indicating that at contact (and, by implication, extending into prehistory) American Indians were processing maple sap into some semblance of syrup.

Still committed to her earlier position, Mason here takes a stance analogous to that of a lawyer trying to defend a client who has been caught with a "smoking gun," attempting to discredit witnesses and raise doubts about or downplay the significance of the facts. The facts are that many of the earliest European observers described the use of a very sweet, wine-like, honey-like, sugarcane juice-like, brown colored *"espèce de sirop"* that was produced from maple sap. The linguistic data, from all four language families of the "maple belt" of northeastern North America, very strongly suggest that the earliest use of sugar was in a liquid, syrup-like form. And both ethnographic and experimental data demonstrate that maple sap can be easily and "profitably" concentrated into syrup with the technology that had been available to Native Americans from "time out of mind."

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## OPINIONS

Readers are invited to submit articles of less than 500 words that comment on the applied aspects of ethnobiological research or other issues of concern to ethnobiologists. Opinion pieces are selected and edited by the News and Comments editor but are not sent for outside review. The opinions expressed are those of the author(s) and do not necessarily reflect the policy of the Society of Ethnobiology, the *Journal of Ethnobiology,* or its editors.

**PARATAXONOMISTS OR ETHNOBOTANICAL PROMOTERS?** by Gary J. Martin, *People and Plants Initiative, Division of Ecological Sciences, Man and the Biosphere Program, UNESCO 7, Place de Fontenoy; 75352 Paris CEDEX 07 SP FRANCE,* and
Michel Pimbert, *Biodiversity Unit, Conservation Policy Division, WWF-International, 1196 Gland, SWITZERLAND*

Ethnoecology is an encounter between two ways of looking at the natural world. One perspective comes from researchers who learn about the environment in universities, laboratories, and excursions into the field. They are usually based in urban areas and often work outside their own country. Because of their education and social position, they are often able to obtain research funds and influence public policy by interacting with representatives of commercial enterprises, development agencies, and international research institutes.

The other view comes from local people who gain their ecological knowledge by observing nature, learning from relatives and elders in their own community, or interacting with people from other cultural traditions. Agriculturalists, pastoralists, or gatherers of forest products, they typically live in rural areas and often speak an indigenous language. Because they are members of ethnic minorities and rural communities, they are often distant from the sources of political power and wealth in their countries.

The relationship between these two groups has been developing over time, from early studies in which local people were simply the objects of scientific

investigation up to recent projects conceived as joint ventures between scientists and villagers (Berlin 1984).

The role of local people in these joint ventures is defined in one of two ways. In some projects, they work as **parataxonomists,** assistants to university-educated biologists. Training consists of showing villagers how to collect samples of plants and animals and prepare them for transport to national museums and laboratories. The parataxonomists are not expected to initiate efforts towards conservation or community development as part of their work. Instead, these actions are directed by national institutions, be they governmental or nonprofit organizations. This top-down approach extracts knowledge for national inventories of biodiversity and programs of nature conservation from which local people are later expected to benefit (Gámez 1991; Janzen et al. 1993).

Another role is as **ethnobotanical promoters,** a term derived from the Spanish *promotores,* which refers to village workers who act to improve health care, foster local culture, or carry out other activities for the benefit of their communities. The promoters learn about ethnobiological methods in participatory workshops in which they define the priorities of the research, who will carry it out, and how it will be applied to benefit the community. These workshops are usually sponsored by organizations interested in community development and the sustainable and equitable use of biological resources.

Contrary to many parataxonomists—who often collect far from home in protected areas and thus pay little attention to recording local biological knowledge—ethnobotanical promoters stay in their own communities to survey local uses of plants. In this way, they are able to integrate their work into the general life of their village, applying the results to community development and the rational use of local resources. Because they are part of the community, they have the special skills necessary to write popular booklets on local ecological knowledge, cultivate gardens of useful plants, and pursue many others ways of returning the results of their research to their fellow villagers.

This grassroots strategy gives local people increasing control over the tools and results of research, putting them in a position to generate development and conservation actions which are appropriate in the context of local political, cultural, and ecological conditions (de Avila and Martin 1990; Chambers 1992). Interest in this approach is now spreading to governmental agencies, universities, and international foundations.

This strategy is particularly important as local people question their participation, both as informants and research assistants, in ethnoecological field studies. They realize that they often lack access to research results and that academics rarely support political and social change at the local level. The leaders of these communities, cognizant of the potential payoffs and pitfalls, are reluctant to allow the research to go ahead unless they can ensure that the results are used for the benefit of everyone.

The best way to foster a harmonious relationship between local people and outside researchers is to ensure common benefits for communities, research institutes, and national programs. This can only be achieved by a participatory approach to ethnobiological research.

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## CONFERENCES AND SEMINARS

The **Society for Conservation Biology** and the **Association for Tropical Biology** will be holding their annual meetings jointly from 7–12 June 1994 at the University of Guadalajara, in the state of Jalisco, Mexico. The meetings will promote the participation of Latin American biologists in both of these professional societies and will provide a good opportunity for networking and learning about conservation biology in the Neotropics. Travel, lodging, and registration costs will be similar to those of meetings held previously in the United States. Information on symposia, contributed papers, poster sessions, and travel arrangements were mailed to members of both societies in November 1993. Deadline for submission of papers will be in early March. For additional information, write or send a fax to:

Eduardo Santana or Stanley Temple
SCB-ATB Organizing Committee
Department of Wildlife Ecology
University of Wisconsin–Madison
Madison, WI 53706 U.S.A
Fax (608) 262-6099

Bruce Benz or Enrique Jardel
SCB-ATB Organizing Committee
Laboratorio Natural Las Joyas
Universidad de Guadalajara
Apartado Postal 1-3933
Guadalajara, Jalisco
C.P. 44100 MEXICO
Fax (52-338) 7-27-49

### Society for American Archaeology Conference Phytolith Symposium: A Summary

A nine-paper symposium entitled "Frontiers in Phytolith Research" was presented at the 1993 Society for American Archaeology (SAA) meetings in St. Louis. Co-chairs were Irwin Rovner and Elizabeth Lawlor. Abstracts will be reprinted in the *Phytolitharien Newsletter* (see *Journal of Ethnobiology* 12:158).

Many of the papers presented new findings in phytolith systematics from a

wide geographical range. Lisa K. Kealhofer reported many newly identified diagnostic phytoliths in plants of Southeast Asia. Kealhofer analyzed phytoliths from 360 species in over 80 families as part of an investigation of the origin of agriculture in Thailand. Terry H. Ball constructed a key to emmer, einkorn, and bread wheat (*Triticum* spp.) by morphometric analysis of silica cells and dendriform cells with computer-assisted image analysis. He achieved confidence levels of 70% to 76%. Judith Zurita Noguera's paper was on phytoliths in noncultivated, ethnobotanically important plants in Mexico, such as cactus and other xerophytes. Elizabeth Lawlor reported a possible phytolith signature for ricegrass *(Oryzopsis hymenoides)* processing in the Mojave Desert and Great Basin; this involved the relative frequency of different types. Alix Powers-Jones discussed the utility of matching "suites" of phytoliths from different plants to their cultural or natural sources; she has used this approach to identify patterns of organic waste disposal on the Outer Hebridean islands of Scotland.

A wide range of applications of phytolith analysis also were reported. Christine Prior and Susan Mulholland reported AMS radiocarbon dates from carbon-occluded phytoliths associated with Paleoindian materials on the Canadian Shield. The minimum dates were substantially older than associated charcoal dates. William Middleton reported ongoing work in microecological reconstruction on St. Catherine's Island, Georgia, using a coring tool to collect samples along a transect intersecting several archaeological features. Linda Scott Cummings reported great abundances of hooked hairs from bean pods in Anasazi coprolites, showing that the Anasazi ate the pods as well as the beans. Finally, Irwin Rovner applied phytolith analysis to historic residential yards at Harpers Ferry, West Virginia. He found patterns reflecting small-scale, short-term uses of the yards, such as vegetable gardening and use of a smokehouse.

We were pleased that the SAA scheduled the symposium in the middle of the schedule and in a central location and that turnout was good (Rovner estimates about 70 attendees). We also were pleased that at least seven papers in other sessions incorporated phytolith analysis. These papers were by Middleton (possible coca phytoliths on Peruvian human teeth); Mulholland (an invited review of advances in phytolith research; and patterns of plant use and discard in North Dakota); Deborah Pearsall (an invited review of advances in Andean paleoethnobotany); Brigitte Holt (possible maize phytoliths on coastal Peruvian human teeth); Arlene Rosen (Early Bronze Age agricultural stress in Western Palestine); and Charles Miksicek (complex combinations of agricultural strategies at Pull-trouser Swamp, Belize).

The Society for Phytolith Research decided at its meeting that a phytolith symposium should be presented annually at the SAA meetings, and Elizabeth Lawlor agreed to chair the next one. That will be held at the Disneyland Hotel, Anaheim, California, April 20–24, 1994. For more information, please contact: Elizabeth J. Lawlor, Department of Anthropology, University of California, Riverside, CA 92521. BITNET LAWLOR@UCRVMS; internet lawlor@ucracl.ucr.edu; FAX (909) 787-5409.

## JOURNALS AND OTHER MEDIA

*Etnobotánica* is a Spanish-language newsletter of the *Grupo Etnobotánico Latinoamericano* [GELA], an organization that seeks to promote scientific exchange among researchers who focus on ethnobotany in Latin America. The first number of *Etnobotánica* was issued in March 1993 and additional numbers will be published on an occasional basis. Among the sections of the newsletter, *Noticias* gives information on networks, programs, databases, and events of interest to ethnobotanists; *Nuevas publicaciones* includes reviews of new books and periodicals and may eventually contain information on theses and other publications of limited distribution; *Investigaciones Etnobotánicas* explores research projects in Latin America which are of general interest to GELA members; *Plantas promisorias* presents synopses about economically promising species used by local people; and *Perfiles* contains profiles of famous ethnobotanists. The first issue contains a data sheet to be filled out by ethnobotanists who wish to be included in a revised edition of the *Directorio Latinoamericano de Etnobotánicos,* which was first published by GELA in 1988. Letters of inquiry about *Etnobotánica* or GELA may be addressed to:

Javier Caballero
Jardín Botánico, UNAM
Apartado Postal 70-614
México, D.F. 04510 MEXICO

Olga Lucia Sanabria
Universidad del Cauca
Apartado Aéreo 304
Popayán, Cauca COLOMBIA

## COURSES AND DEGREES IN ETHNOBIOLOGY

A request was made in previous issues of the Journal for information on university-level degree programs and courses in ethnobiology. The following is the first response. If you wish to provide information about programs please contact the News and Comments editor.

The **School for Field Studies** offers a summertime course in Ecuador called "Ethnobotany: Uses of Plants by Native Peoples," which integrates lectures and practical field work in the Amazon basin. Each course has two four-week sessions. It was taught in 1989 and 1990 by Bradley Bennett and in 1991 by Christine Franquemont and Donald Hazlett, all active members of the Society for Ethnobiology. It was offered most recently from June to August 1993 by Shawn Sigstedt. Rocío Alarcón of Ecuador has served as associate instructor each year. For additional information on this and other courses on tropical ecology, conservation, and sustainable development, contact: Anne Dodge, Director of Satellite Programs, The School for Field Studies, 16 Broadway, Beverly, MA 01915-4499; Tel. 1.508.927-7777; Fax 1.508.927-5127.

## BOOK REVIEWERS NEEDED

The following new titles have been received for review in the *Journal of Ethnobiology:*

**Life Cycles. Reflections of an Evolutionary Biologist.** John Tyler Bonner. Princeton, New Jersey: Princeton University Press, 1993. Pp. 209. $19.95 (hardcover). ISBN 0–691–03319–6.

**Kava. The Pacific Drug.** Vincent Lebot, Mark Merlin, and Lamont Lindstrom. New Haven, Connecticut: Yale University Press, 1993. Pp. 255. $45.00 (hardcover). ISBN 0–300–05213–8.

**Smallholders, Householders.** Robert McC. Netting. Stanford, California: Stanford University Press, 1993. Pp. xxi, 389. $49.50 (hardcover), $16.95 (paperback). ISBN 0–8047–2061–4 (hardcover), 0–8047–2102–5 (paperback).

**Pharmacotheon. Entheogenic drugs, their plant sources and history.** Jonathan Ott. Kennewick, Washington: Natural Products Co. 1993. Pp. 640. $70.00 (hardcover), $40.00 (softcover) plus $4.00 shipping and handling. ISBN 0–9614234–2–0 (hardcover), 0–9614234–3–9 (softcover) (Distributed by agAccess, 603 Fourth Street, Davis, California 95616)

**Sweet Potato Cultures of Asia and South Pacific. User's Perspective with Agricultural Research and Development.** Robert E. Rhoads and Virginia N. Sandoval (editors). Proceedings of the 2nd Annual Upward International Conference. Los Banos, Laguna, Philippines, 1991. Pp. 490. ISBN 971–614–001–0.

**The Iron Age Community of Osteria dell'Osa. A Study of Socio-political Development in Central Tyrrhenian Italy.** Anna Maria Bietti Sestieri. Cambridge, U.K.: Cambridge University Press, 1992. Pp. xii, 271. ISBN 0–521–32628–1.

**Polynesian Herbal Medicine.** W. Arthur Whistler. Lawai, Kauai, Hawaii: National Tropical Botanical Garden, 1992. Pp. x, 238. ISBN 0–915809–16–8.

We still need reviewers for the following titles:

**Human Adaptation in the Upper Mississippi Valley: A Study of the Pammel Creek Oneota Site (47Lc61) La Crosse Wisconsin.** Constance M. Arzigian, Robert F. Boszhardt, James L. Theler, Roland L. Rodell, and Michael J. Scott. The Wisconsin Archaeologist, Volume 70 (Nos. 1–2, 1989). Monograph of the Mississippi Valley Archaeology Center, University of Wisconsin–La Crosse [Wisconsin Archeological Society, Office of Publication, P.O. Box 1292, Milwaukee, Wisconsin 53201]. Pp. 280. $12.00 (paperbound).

**The Palm—Tree of Life: Biology, Utilization and Conservation.** Michael J. Balick (Editor). Proceedings of the Symposium at the 1986 Annual Meeting of the Society for Economic Botany held at the New York Botanical Garden, Bronx, New York. Bronx: The New York Botanical Garden, and Lawrence, Kansas: Allen Press, 1988. Pp. 282. $53.75 (paperbound). ISBN 0–89327–326–0.

**Herbal Dentistry. Herbal Dental Remedies from Ancient Times to the Present Day.** Joseph G. Carter and William J. Carter. Chapel Hill: The University of North Carolina, 1990. Pp. 77 (typescript). $17.95 (softcover). ISBN 0–930989–01–8.

**Folk Dentistry. Cultural Evolution of Folk Remedies for Toothache.** Joseph G. Carter and William J. Carter. Chapel Hill: The University of North Carolina, 1990. Pp. 104 (typescript). $17.95 (softcover). ISBN 0–930989–01–9.

**The Marana Community in the Hohokam World.** Suzanne K. Fish, Paul R. Fish, and John H. Marden (Editors). Anthropological Papers, Number 56. Tucson: The University of Arizona Press, 1992. Pp. 121. ISBN 0–8165–1314–7.

**The Ethnobotany of Southern Balochistan, Pakistan, with Particular Reference to Medicinal Plants.** Steven M. Goodman and Abdul Ghafoor. Fieldiana: Botany: New Series, No. 31, 1992. Pp. v, 84. ISSN 0015–0746.

**Agriculture and the Onset of Political Inequality before the Inka.** Christine A Hastorf. New York and Cambridge: Cambridge University Press, 1993. Pp. xv, 298. $69.93. (hardback). ISBN 0–521–40272–7.

**The Tasaday Controversy: Assessing the Evidence.** Thomas N. Headland (Editor). Washington, D.C.: American Anthropological Association Special Publication No. 28, 1992. Pp. xi, 255. $19.95 (paperbound). ISBN 0–913167–51–7.

**The State of Nature: Ecology, Community, and American Social Thought, 1900–1950.** Gregory Mitman. The University of Chicago Press, Chicago, Illinois, 1992. Pp. 290. ISBN 0–226–53236–4.

**Butterflies of the Bulolo-wau Valley.** Michael Parsons. Handbook No. 12 of the Wau Ecology Institute, Wau, Papua New Guinea. Honolulu: Bishop Museum Press, 1991. Pp. 280. $30.00 (paperbound). ISBN 0–930897–61–7.

**New Directions in the Study of Plants and People: Research Contributions from the Institute of Economic Botany.** Ghillean T. Prance and Michael J. Balick (Editors). Bronx: The New York Botanical Garden, Scientific Publications Department, 1990. Pp. 278. $55.00 (paperbound). ISSN 0741–8280.

**Phytolith Systematics: Emerging Issues.** George Rapp, Jr., and Susan C. Mulholland (Editors). New York: Plenum Press, 1992. Pp. 350. $49.50 (hardcover). ISBN 0–036–44208–6.

**Rivers of Change: Essays on Early Agriculture in Eastern North America.** Bruce D. Smith. Washington, D.C.: Smithsonian Institution Press, 1992. Pp. 302. ISBN 1–56098–162–8.

**Native American Cultural Resource Studies at Yucca Mountain, Nevada.** Richard W. Stoffle, David B. Halmo, John E. Olmsted and Michael J. Evans. Ann Arbor: Institute for Social Research, The University of Michigan, 1990. Pp. xxiv, 232. ISBN 0–87944–328–6.

**Progress in Old World Palaeoethnobotany. A retrospective view on the occasion of 20 years of the International Work Group for Palaeoethnobotany.** Willem van Zeist, Krystyna Wasylikowa and Karl-Ernst Behre (Editors). Rotterdam, Netherlands and Brookfield, Vermont: A.A. Belkema, 1991. Pp. ix, 350. $60.00 (hardcover). ISBN 90–6191–881–2.

**Persephone's Quest: EntheOgens and the Origin of Religion.** R. Gordon Wasson, Stella Kramrisch, Jonathan Ott, and Carl A.P. Ruck. New Haven, Connecticut: Yale University Press, 1986. Pp. 257. $37.00 (clothbound). ISBN 0–300–03877–1.

If you would like to review any of these books and would be able to have your review completed within four months after receiving the book, please write to:

Nancy J. Turner
Book Review Editor for the *Journal of Ethnobiology*
Environmental Studies Program, P.O. Box 1700
University of Victoria
Victoria, British Columbia
CANADA V8W 2Y2
phone: (604) 721-6124

## TROPICAL BOTANIST/ETHNOBOTANIST

The Conservation Science Program, World Wildlife Fund-US, invites applications for a full-time position for a tropical botanist/ethnobotanist available immediately. The primary responsibilities of the tropical botanist are to (1) provide expertise and leadership in tropical botany; (2) conduct research on sustainable use of wild plant populations; (3) assist in design, monitoring, and evaluation of biodiversity conservation efforts in extractive reserves; and (4) contribute to the growth of the conservation science program at WWF by collaborating with regional staff in field projects and through publications, lectures, and public outreach. The successful applicant must hold a doctoral degree in botany, plant ecology, conservation biology, or natural resources management (and at least five years experience in tropical countries). Fluency in Spanish, French, or another language other than English is preferred. Competitive salary and benefits appropriate to the nonprofit sector will be provided. Please forward curriculum vitae, a description of research goals, relevant publications, and the names, addresses, and telephone and fax numbers of three references to: World Wildlife Fund, Human Resources Dept. 344JE, 1250 24th St NW. Washington, DC 20037.

## BOOK REVIEW

**Cognitive Foundations of Natural History: Towards an Anthropology of Science.** Scott Atran. Cambridge: Cambridge University Press, 1990. Pp. xii, 360. $39.50 (hardcover). ISBN 0–521–372–92–3.

Many people view folk taxonomy as something apart from and essentially different from the supposedly more rational scientific nomenclature. They fail to realize the close historical and semantic relationship between the two, ignoring the fact that scientific taxonomy represents an extension and codification of European folk taxonomy. In this book, Scott Atran traces in great detail the historical and philosophical origins of taxonomic nomenclature, from traditional folk taxonomy through Aristotle and Linnaeus to the nineteenth century biologists who established the familiar present-day system. The author concentrates on the semantic criteria used in taxonomic decision-making at each step along the way. He discusses how traditional overt and covert European folk taxonomy gave rise to many contemporary biological concepts. Some of the ideas have been published elsewhere previously (Atran 1983, 1985a, 1985b, 1987a, 1987b, 1989), but others are presented for the first time in this book.

Atran's work has profound implications both for ethnotaxonomic studies and for modern systematics. In discussing folk taxonomy he challenges the framework which has guided the study of ethnotaxonomy for over 20 years. Berlin et al. (1966, 1968, 1973) postulated that folk taxonomies tend to be organized hierarchically, much in the same manner as scientific taxonomy, with the chief categories being unique beginner, life form, folk genus, folk species, and folk variety. Atran criticizes this viewpoint from several perspectives. First, he maintains that folk taxonomy is not strictly hierarchical, since many folk genera cut across life form boundaries. Indeed, such basic English folk groupings as pines, oaks, willows, maples, alders, dogwoods, yews, and junipers have both shrubby and arboreal members. This, maintains Atran, is the basis for the modern botanical system which continues to utilize life form categories as important descriptive terms while recognizing that they are not phyletic taxa. Many families such as grasses, palms, umbelliferates, and orchids are readily recognizable to nonbotanists. Some have common names, while others represent covert categories, recognized by people as distinct but unnamed groups.

Atran also lumps together the folk generic and folk specific categories into the "generic-specieme." He maintains that most members of this category are monolexemic, and that most binomial folk taxa represent either compound names, attempts to broaden a localized folk taxonomy to include novel items, or folk varieties with a very limited number of sharply contrasting descriptors such as "black" and "white." Significant expansions of folk binomials occur when large numbers of exotic species are added to a preexisting system, e.g., during the invasion of English-speaking peoples into North America. Other allegedly "common" names arise artificially when biologists deliberately coin such names for all the species of a large geographic region. Some of these are mere translations of scientific binomials (e.g., Richardson's hymenoxys for *Hymenoxys richardsonii;* Hitchcock and Cronquist 1973). True folk taxonomies are designed primarily for use within a restricted geographic area.

Recognizing the folk taxonomic origins of modern taxonomy helps explain several controversies in the history of modern systematics. Our species concept is rooted in the common perception of the permanent separateness of different kinds of organisms. With further study scientists have discovered difficulties with the original concept, such as hybridization, apomyxis, introgression, polyploidy, and evolutionary changes within a given species through time. At each turn, scientists have attempted to redefine the species concept to fit these new situations, mostly in the direction of retaining the status quo as nearly as possible. For example, many plants which are capable of reproducing in the laboratory but which for one reason or another do not regularly do so in nature are usually regarded as separate taxonomic species. On the other hand, groups which are incapable of cross-breeding because of polyploidy or asexual reproduction are frequently regarded as a single taxonomic species when these are morphologically indistinguishable even though they may meet most strict criteria for biological species. Both of these examples illustrate the attempts of scientists to perpetuate the traditional system founded on the idea of reproductively isolated, morphologically distinguishable entities.

Attempts by members of the systematics community to move too far from folk

taxonomy, either at the species level or higher up, often meet with fierce opposition from other systematists. Attempts to split or lump readily recognizable taxa are (justly or unjustly) resisted, e.g., Dahlgren et al.'s (1985) splitting of the Liliaceae and Orchidaceae into several separate families. Attempts to modify or abolish paraphyletic taxa such as fish and reptiles (Laferrière 1989) meet strong resistance, especially when such taxa reflect long-standing folk taxonomy at the life form level.

The point here is not that folk taxonomy should be either followed blindly or totally ignored in modern systematics. Scientific taxonomy differs from folk taxonomy in several respects. It is strictly hierarchical, it aims to include all species on the planet, and it attempts to avoid polyphyletic taxa (opinion is divided as to whether it should avoid paraphyletic ones as well). The rules on priority, typification, and publication of descriptions are designed to ensure stability and enhance universality of usage. However, the scientific system shares with folk taxonomy the general purpose of helping people categorize information and render the vast diversity of the natural world more manageable. In general it therefore seems preferable to maintain official recognition of folk taxa in formal taxonomy provided, of course, that the more rigorous standards of modern systematics are followed.

Atran's book is rather thickly and abstrusely written. The reader must frequently go searching for main points which should have been stated more clearly and succinctly. This is definitely not a book for skimming or speed-reading. Nevertheless, the ideas expressed are provocative and represent a significant contribution to the study of ethnotaxonomy.

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Joseph E. Laferrière
Arnold Arboretum of Harvard University
22 Divinity Ave.
Cambridge, MA 02138

# BOOK REVIEW

**Phytochemical Resources for Medicine and Agriculture.** Herbert N. Nigg and David Seigler (editors). New York: Plenum Publishing Corporation, 1992. Pp. 445. $95.00 (outside of United States: $114.00). ISBN 0–306–44245–0.

The material in this book was presented in 1989 in a symposium held during the American Chemical Society meeting at Miami Beach, Florida, and sponsored by the Society for Economic Botany and the American Chemical Society Food and Natural Product section.

The editors state in the Preface, "we believe this work is the finest anywhere and that readers will find all of the chapters interesting, intriguing and educational." This reviewer certainly accepts this modest belief, as he is certain that anyone consulting the book will agree with its uniqueness and outstanding utility.

The contents comprise 13 contributions by 15 specialists: 1) An Historical Perspective of Ancient Poisons (H.G. Cutler); 2) Plants and Plant Products used in Mummification (A.R. David); 3) Plants Used Medicinally by Indigenous Peoples (W.H. Lewis); 4) Plants as Sources of Medicinally and Pharmaceutically Important Compounds (A.D. Kinghorn); 5) Socio-Economic Poisons: Khat, the Natural Amphetamine (R. Brenneisen and M.A. El Schly; 6) Antiparasitic Agents from Plants (R.P. Borres and J.M. Schaeffer); 7) Antifungal Compounds from Plants (J. Kuc); 8) Nematicidal Compounds from Plants (D.J. Chitwood); 9) Herbicidal Compounds from Higher Plants (H.G. Cutler); 10) (W.S. Bowers); 11) Natural Medicines are Natural Pesticides? (J.A. Duke); 12) Natural Toxicants in Foods (R.C. Beier and H.N. Nigg); and 13) Future for Natural Products (H.N. Nigg and S.S. Seigler).

It would be difficult to find a single volume with such a widespread selection of authentic articles on natural products.

Each contribution has a comprehensive bibliography. There is a taxonomic index, a chemical index and a subject index.

There can be no doubt that this volume will be a *vade mecum* to researchers in a wide span of scientific fields.

Richard Evans Schultes
Botanical Museum of Harvard University
Cambridge, Massachusetts 02138

# NOTICE TO AUTHORS

The *Journal of Ethnobiology* has published "Guidelines for Authors" in Volume 10, Number 2 (Winter 1990). Many authors will be able to prepare their manuscripts by consulting recent issues of the *Journal*. If you need a copy of the "Guidelines for Authors" please consult the issue of the *Journal* in which it was first published or write to the Editor requesting a copy.

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## NEWS AND COMMENTS

Individuals with information for the "News and Comments" section of the *Journal* should submit all appropriate material to Gary J. Martin, 94 Blvd. Flandrin, 75116, Paris, France. FAX: 33/1/45533001.

## BOOK REVIEWS

We welcome suggestions on books to review or actual reviews from readership of the *Journal*. Please send suggestions, comments, or reviews to one of the *Journal*'s book review editors. Please see inside front cover for names and addresses.

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